POWER

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HELPFUL HINTS

On Gathering Knowledge

TO a certain extent the brain is like a peach basket; it will hold only so much.

If given access to a fine orchard and permitted to have but one basketful, one would naturally select with care and pick the choicest fruit. Now the tree of knowledge is accessible to all, and the fruit it bears is information.

The wise man does not stay on the ground and gather whatever falls; he climbs for the choicest fruit. The foolish man may take the first fruit at hand, and when his basket is full of small peaches he has no room for the better ones he may find later. How much more important it is, since the capacity of a man's brain is limited, that he gather his knowledge with care lest the useful be crowded out by the trifling.

This idea came to me from an analysis of my own experience. Like many others, I have had to get my education while taking care of myself and mother. I soon found that most of the technical books on the market were not suitable to home study. I not only spent hard-earned money in obtaining them, but frequently found that they did me more harm than good. Some were too advanced for my limited knowledge and only served to confuse me in what little I did know. Others had only short explanations, obviously intended to be supplemented by a teacher's help.

I also fell into the rut of buying cheap books. Most of them were found to be antiquated.

There is no doubt about it—books are a man's best friends, but he should be careful how he chooses his friends.

Contributed by G. S. WILLS *Twin Butte, Ariz.*

Coal Handling at Panama

SYNOPSIS—This summer will see the completion of the two great coal-handling plants on the Panama Canal. The plant at Cristobal, on the Atlantic side, has a storage capacity of 400,000 tons, and that at Balboa, on the Pacific side, a little over 200,000 tons, divided into piles. The Cristobal plant will be capable of handling 2000 tons per hour and the Balboa plant about one-half that. The total cost, substructure and superstructure, will be about three and a half million dollars. Some wet-storage capacity is provided.

For military and commercial reasons it becomes necessary to provide in the Canal Zone great coal-handling plants. At this time it is not possible to estimate closely the quantity of coal these plants will handle yearly, but, based upon the expected canal traffic and the amount of coal transfered at the entrance of the Suez Canal, it is assumable that in time the Isthmus may be expected to handle upward of one million tons a year.

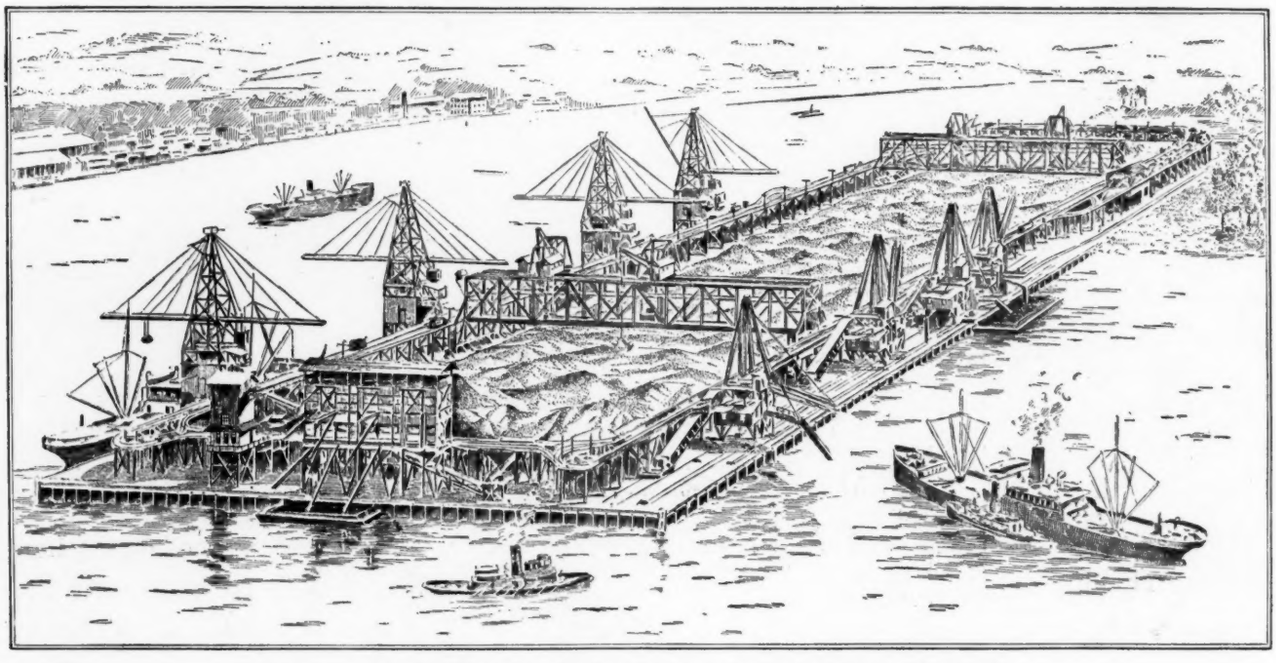


FIG. 1. COAL-STORAGE PLANT AT CRISTOBAL, CAPACITY 485,000 TONS

Two plants are provided, one at Cristobal, Fig. 1, on the Atlantic side of the Isthmus, and one at Balboa, Fig. 2, on the Pacific side. The former will have a solid storage capacity of 485,000 tons, while the capacity of the latter will be 215,000 tons. This is based on short tons of 2000 lb. each, or on 40 cu.ft. per ton. If, however, the coal is divided into piles, as it probably will be, it will reduce the capacity below these figures. For example, in case the coal at the Cristobal plant is divided into 37 piles, the collective capacity will be not far from 400,000 tons. Of this storage capacity, and at the request of the Navy Department, 100,000 tons of wet storage is provided for at Cristobal and 50,000 tons at Balboa. The wet-storage capacity is to provide for the permanent storage of large amounts of coal without it being subjected to the deterioration in quality that occurs in long exposure to the air, and it also will avoid the loss in damage through spontaneous combustion, although the machinery is so equipped that burning coal may be easily transferred to places where it can do little damage. Wet-storage may not be used except in case of war.

The plans and sectional elevations, Figs. 3 and 4, indicate clearly how the plants are laid out.

The substructure of the Cristobal plant is made up of three large wharves. One at the long side of the pier is designated as the unloader wharf, and at the other side is the reloader wharf. The connecting wharf between the two at the water end of the coaling plant is known as the end wharf. A depth of 41 ft. at mean sea level has been provided for a distance of 1965 ft. along the unloader and the reloader wharves, and also at the end wharf. The plant has about 2500 lin.ft. of berthing space, with 41 ft. depth at mean sea level, and as the tide does not fall more than one foot below sea level, deep-draft vessels can be accommodated at any stage of the tide. The decks of all wharves are 10 ft. 6 in. above the mean sea level.

Referring to Figs. 1 and 3, the coal pile is spanned by two movable steel structures, known as the stocking and reclaiming bridges, which are capable of traveling the length of the pile, or about 1000 ft. These bridges are of heavy steel construction and supported on 32 wheels at each end, the unloader wharf affording support for one of them and the reloader wharf for the other. These bridges are a little over 315 ft. long. The upper chord of each supports moving units known as bridge diggers, each of which consists chiefly of a bucket that can command any part of the storage pile. It will be seen from Figs. 1 and 3 that while the bridge moves longitudinally of the pile, the bridge diggers move longitudinally of the bridge.

On the unloader wharf there are provided four great unloader towers, a good view of which is shown in Fig. 3. These have a travel of slightly more than 1000 ft. and command the length of the deep-water berth on the unloader side of the plant. Their function is, of course, to unload coal from colliers and barges. The reloader wharf affords support for four moving units known as reloaders, and the maximum range of travel of these is such that they command practically all of the deep-water berth on the reloading side of the plant. The end wharf affords support for a wharf bunker of 15,000 tons' capacity, which is provided for the supply of coal to tugs and other comparatively small craft, thus making it unnecessary to start the plant to furnish small amounts of coal. The unloaders are operated by steam, while the remainder of the plant is operated by electricity. All parts are electric lighted throughout.

The Panama Canal supplies electric current for the coal plant at 2300 volts to a substation on the west bank of the plant. The current is kept down to 440 volts for power and 110 for lighting, some of the necessary transformers being located in the moving units themselves and the remainder in the substation mentioned. The 2300-volt current will be supplied from the main Cristobal substation and will be brought to the coaling-plant substation, submarine cables being used to effect a crossing of the French canal which separates the coaling plant from the mainland.

An interesting point to note is that the tracks on stocking and reclaiming bridges are of the standard 5-ft. gage of the Panama Railroad, and they will be connected at the south end to the lines of this railroad. Thus there will be four parallel lines of standard-gage tracks extending the full length of the plant and connecting two of the main lines of the Panama Railroad. This will, of course, effect the convenient transportation of coal to and from the storage plant by rail.

Briefly, the substructure consists of steel and concrete decks supported by concrete cylinders 6 ft. in diameter, founded on solid rock. The spacing of the cylinders is largely dependent on the spacing of the rails for the support of the moving units, and the design of the deck framing has also been largely influenced by the position of the superimposed load. The deck-structure framing consists of steel plate-girders and beams. In all there was required about 5000 tons of structural steel and 18,000 cu.yd. of reinforced concrete. To support these decks, which have an area of about 200,000 sq.ft., 306 concrete cylinders, 6 ft. in diameter and ranging between 50 and 75 ft. in length, were required. These foundations were necessary inasmuch as the loads to be carried will, in many cases, be very heavy; for example, a load imposed on the substructure by one end of the stocking and reclaiming bridge can reach a maximum of nearly 1000 tons. The substructure of the Balboa plant is similar to that at Cristobal.

For loading and stocking, coal is taken from colliers or barges by one or four of the unloaders, which are equipped with 2½-ton buckets and have a normal rated capacity of 250 tons per hour each, or the four unloaders at Cristobal have a combined unloading capacity of 1000 tons per hour. The coal is delivered to cars running on the elevated railroads. Each car has a capacity of 10 tons and runs at a speed of 200 ft. per min. The cars are stopped and started by a trackman working on the viaduct, no attention being necessary when they are in motion.

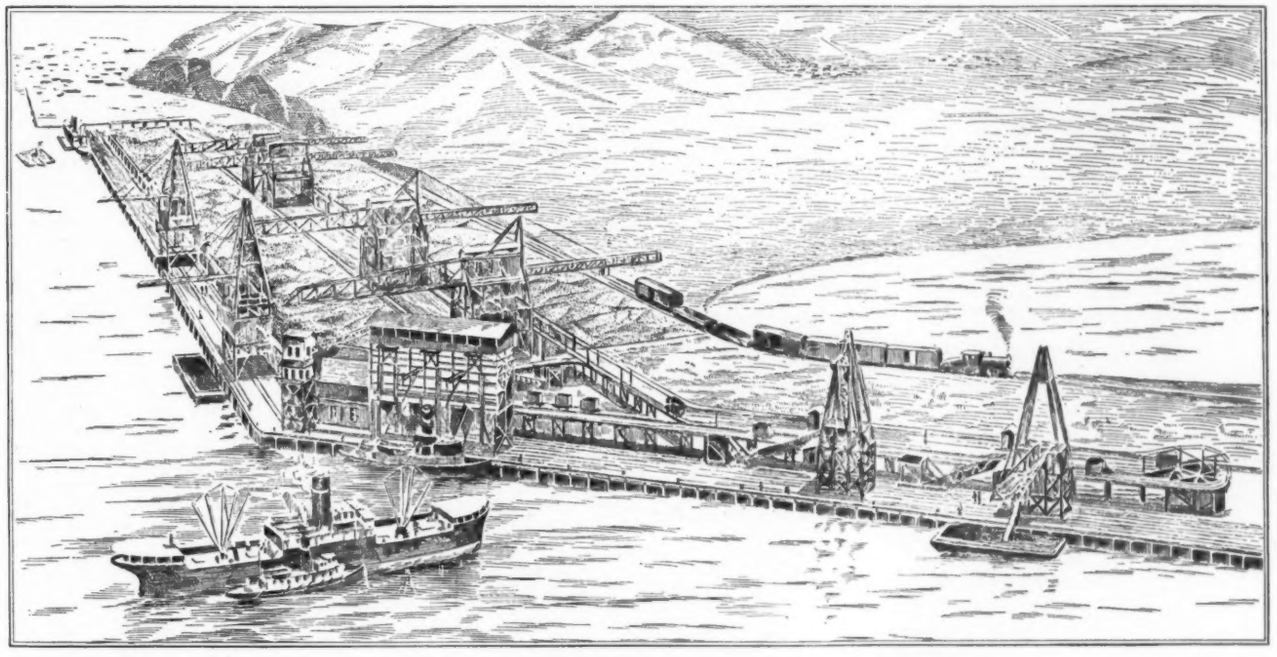


FIG. 2. COAL PLANT AT BALBOA, CAPACITY 215,000 TONS

As shown in the drawings, the cars open at the bottom and are dumped by the trackmen. Throwing of switches is avoided, as the cars are started and travel to the desired point over a predetermined route. For stocking, the cars must dump at some point over the coal pile, and this is done from a track at about the level of the lower chords of the stocking and reclaiming bridges, which track is connected with one of the elevated tracks on the viaduct, paralleling the bridge track by means of a sliding switch that moves with the bridge and guides the cars on to the bridge.

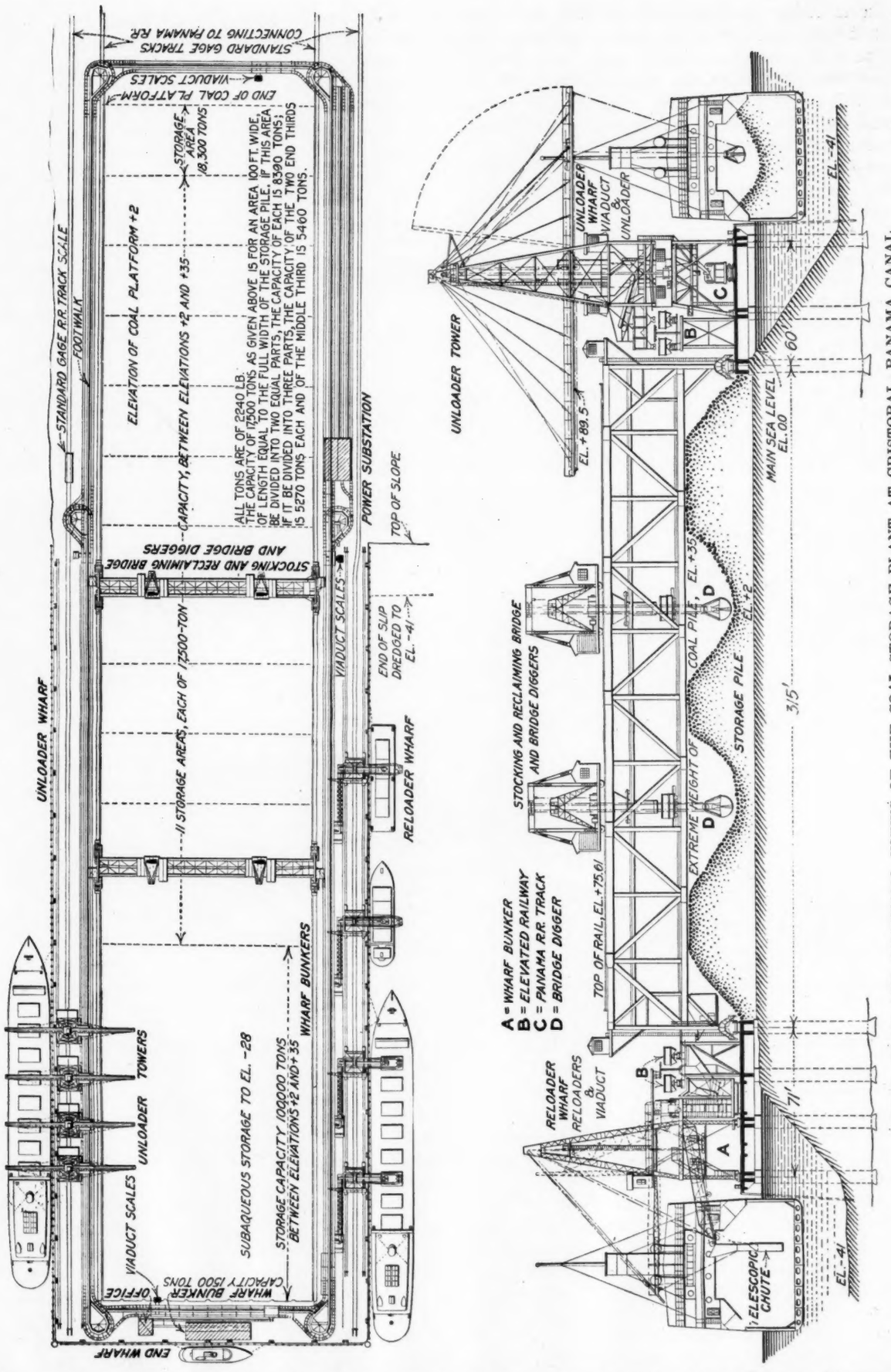

STANDARD GAGE TRACKS CONNECTING TO PANAMA RR
VIADUCT SCALES
END OF COAL PLATFORM
STANDARD GAGE R.R. TRACK SCALE
FOOTWALK
STORAGE AREA 18,300 TONS
ELEVATION OF COAL PLATFORM +2
CAPACITY, BETWEEN ELEVATIONS +2 AND +35
ALL TONS ARE OF 2240 LB.
THE CAPACITY OF 17500 TONS AS GIVEN ABOVE IS FOR AN AREA 100 FT. WIDE, OF LENGTH EQUAL TO THE FULL WIDTH OF THE STORAGE PILE. IF THIS AREA BE DIVIDED INTO TWO EQUAL PARTS, THE CAPACITY OF EACH IS 8390 TONS; IF IT BE DIVIDED INTO THREE PARTS, THE CAPACITY OF THE TWO END THIRDS IS 5270 TONS EACH AND OF THE MIDDLE THIRD IS 5460 TONS.
POWER SUBSTATION
TOP OF SLOPE
STOCKING AND RECLAIMING BRIDGE AND BRIDGE DIGGERS
VIADUCT SCALES
END OF SLIP DREDGED TO EL. -41
UNLOADER WHARF
11 STORAGE AREAS, EACH OF 17500 TON
RELOADER WHARF
WHARF BUNKERS
STORAGE CAPACITY 100000 TONS BETWEEN ELEVATIONS +2 AND +35
SUBAQUEOUS STORAGE TO EL. -28
UNLOADER TOWERS
VIADUCT SCALES
OFFICE
WHARF BUNKER CAPACITY 1500 TONS
END WHARF
UNLOADER TOWER
UNLOADER WHARF VIADUCT & UNLOADER
EL. +89.5
EL. -41
MAIN SEA LEVEL EL. 00
60'
STOCKING AND RECLAIMING BRIDGE AND BRIDGE DIGGERS
EL. +35
EL. +2
COAL PILE
STORAGE PILE
315'
EXTREME HEIGHT OF
TOP OF RAIL, EL. +75.61
A = WHARF BUNKER
B = ELEVATED RAILWAY
C = PANAMA R.R. TRACK
D = BRIDGE DIGGER
RELOADER WHARF RELOADERS & VIADUCT
71'
ELESCOPIC CHUTE
EL. -41

FIG. 3. PLAN AND SECTIONAL VIEWS OF THE COAL-STORAGE PLANT AT CRISTOBAL, PANAMA CANAL

The coal is reclaimed from storage by one or more of the four bridge diggers that run on the top chords of the restocking and reclaiming bridges. Each of these bridge diggers is equipped with a 5-ton bucket and has a normal rating capacity of 500 tons per hour, giving a total hourly capacity of 2000 tons. The reclaimed coal is delivered

by suitable hoppers and valves in cars that transport the coal to the desired points, which may be near the unloaders, wharf bunkers, or to parts of the storage pile, by means of the stocking and reclaiming bridge.

The wharf bunker receives its coal by means of a series of belts fed from a hopper into which the coal is dumped from cars. The reloaders are also supplied with coal by belts. Each reloader is provided with an appendage known as a trailer, consisting essentially of a hopper supported on wheels, which receives coal from the cars and delivers it to an inclined belt supported by a truss that connects the wheeled hopper to the reloader proper. The trailer therefore travels with the reloader. From this inclined belt the coal is delivered to a second belt, carried by the reloader proper, and supported by a hinged truss capable of considerable range of motion in a vertical plane and fitted at its swinging end with a hinged telescopic chute. The hinged truss and chute are raised and lowered by a steel-wire rope passing over sheaves secured to the tower structure and actuated by drums.

It will be seen that these reloaders have a considerable range of point of discharge and that they take the place of the heavy and expensive wharf bunkers usually provided in large coal-handling plants. They are comparatively inexpensive and afford a range in capacity of discharge equal to that of a high wharf bunker.

The coal is weighed by semiautomatic scales provided at points along the elevated railroad, and the operating routes are such that a car must pass over a scale before reaching its point of discharge. A set of standard railroad scales is also provided for the railroad track at the wharf level, so that the weight of coal delivered to standard-gage railroad cars by the unloaders may be ascertained.

Signals and Capacities

A complete system of communication and signals, both visible and audible, is provided. Electric illumination is profusely provided, so that work may be carried on at night. It is not expected that the unloaders will be able to be worked at the same capacity at night as in the day, but every signal device, illumination, communication, control, etc., has been provided to reduce the loss of time to a minimum.

To provide for the safety of those operating the machinery, it was specified that no operation calling for high speed should require the simultaneous thought or action of more than one man. In the design of the machinery, consideration was given to the possibilities of protecting operators from the fumes and gases when removing burning coal. It was also stated in the specifications that each plant and the arrangement and character of its component parts should be such that failure of one part only should not bring the entire plant to a standstill. This referred especially to the conveyor system, wherein bypasses, intermediate storage hoppers, parallel lines, etc., should be provided to enable the handling of coal into and out of storage to proceed continuously and at as great a percentage of the normal rate as practicable, in the event of a breakdown of any part.

The operations of which the various elements of the plant shall be capable are of interest. Each unloading tower is capable of mining coal from the vessels and depositing it into the hopper built into the tower, whence it may be delivered through chutes to the conveying system or to standard 5-ft. gage railroad cars. The tower must also mine coal from the vessels and deposit it by buckets or shovels into the storage pile behind the towers; and it must mine coal from the storage pile behind the towers and deposit it into the hopper built into the tower; and it must mine coal from the storage pile and deposit it by buckets or shovels aboard vessels.

Each stocking and reclaiming bridge must be capable of restocking coal into any part of the storage pile by means of a part of a conveyor system supported by the bridge, and must reclaim coal from any part of the pile and deliver to the conveyor system. In addition to this it must be capable of stocking and reclaiming simultaneously, each at full normal rated capacity.

Functions of Conveying System

The conveying system has many duties. It is capable of receiving coal from a single unloading tower, or group of towers located anywhere on the wharf and transporting it to any part of the storage pile. It also receives coal from a single unloading tower or group of towers located anywhere on the wharf and transports it direct to the reloaders, which may be spaced at any interval along the unloading wharf, and delivers it to one only, or distributes it among any number of reloaders. The aim is to distribute the coal approximately equally among any number of reloaders in action. The conveying system can also receive coal from a single unloading tower or from two towers located anywhere on the wharf, and transport it direct to the wharf bunkers. It was stipulated in the specifications that the capacity of the conveying system leading to the wharf bunker must be sufficient to handle the maximum discharge from two unloading towers. The system is capable of receiving coal from a single unloading tower or group of towers, located anywhere on the wharf, as when unloading but one vessel, and transporting it to any part of the pile, while at the same time coal is being reclaimed from any part of the pile, and being conveyed to reloaders or to the wharf bunker. It also is capable of receiving coal simultaneously from two vessels located anywhere along the unloading wharf and transporting it from both vessels to the same part of the pile, to the reloaders direct, or to the wharf bunker direct. If coal from both vessels is being transported to the storage pile, it is possible simultaneously to reclaim coal from any other part of the pile, by means of running the bridge or bridges, and transport the coal to the reloaders direct, or to the wharf bunker direct. The system is also capable of taking coal from any part of the storage pile and depositing it at any other point of the pile by the use of the bridges.

The plant at Balboa has only about half the capacity both in storage and in handling as has the plant at Cristobal. From the foregoing description and from the illustrations the differences in the two plants are readily seen.

All of the machinery, with the exception of the six unloader towers—four for Cristobal and two for Balboa—were furnished by the Bergen Point Iron Works, the contract price being $1,347,392. The unloader towers were furnished by the Hunt Construction Co., the contract price being $485,736, making a grand total of $1,833,128 for the machinery. These figures, with a

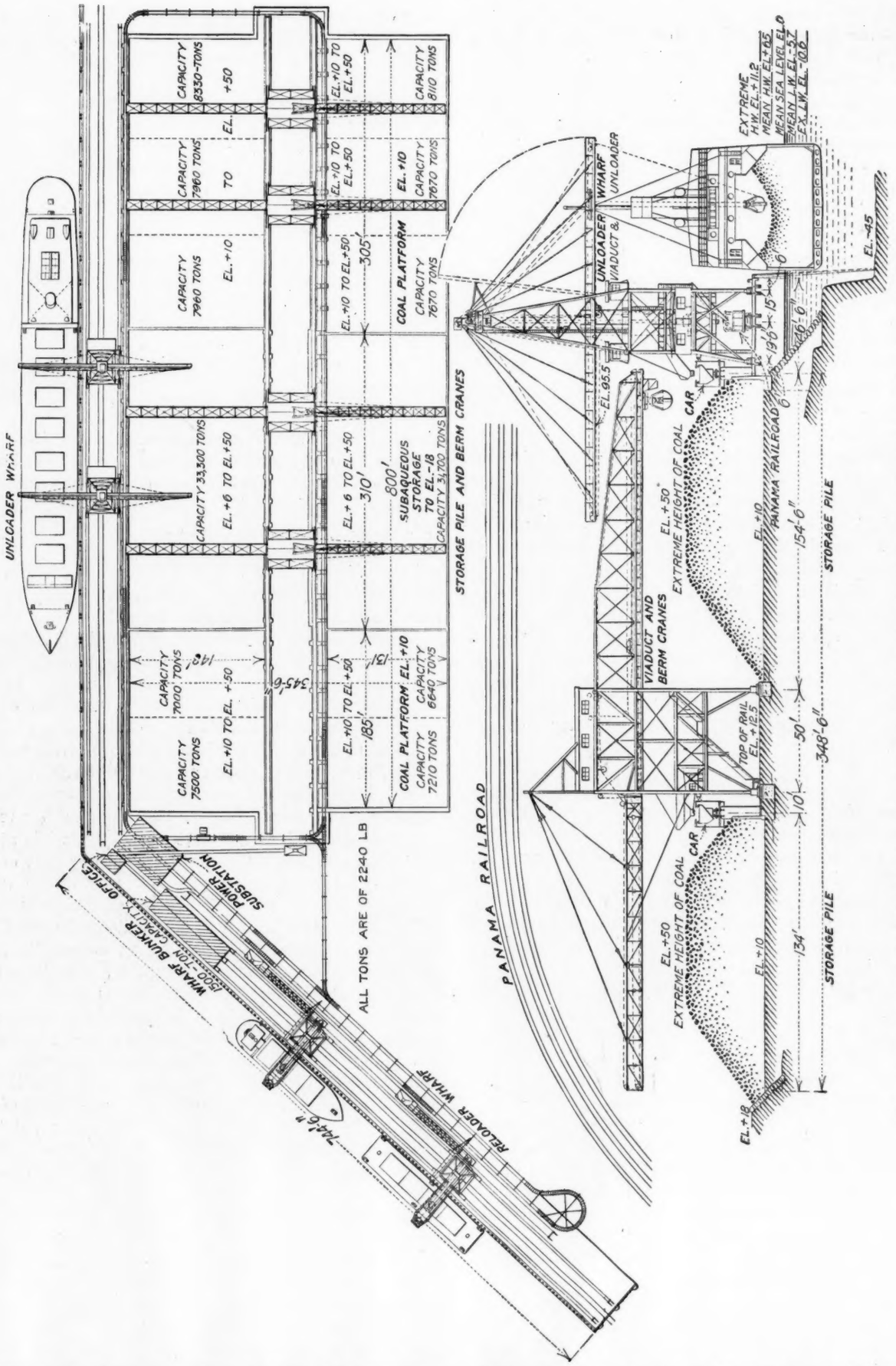


FIG. 4. PLAN AND SECTIONAL VIEWS OF THE COAL-STORAGE PLANT AT BALBOA, PANAMA CANAL

statement in the specification to the effect that "the fact that the cost of the substructure which will be furnished by the Commission will be the greater part of the cost for the entire plant should be kept in mind in the design of the coal-handling installations," would indicate that the total cost of both plants exceeds $3,500,000.

New Morrison Hotel Plant--II

By Thomas Wilson

SYNOPSIS—Two CO_2 refrigerating machines, rated at a total of 180 tons' capacity cool the ventilating air, drinking water and refrigerators. The house water-service piping is divided in three sections and pressures. Seven of the eight elevators are of the helical-gear traction type, the first in the city. An intricate fire-alarm system and a number of the latest devices are employed for communicating between the plant and other parts of the building.

Refrigeration has been provided to cool the air for ventilation, to cool the drinking water and the various refrigerators throughout the building and for ice-making. The refrigerating medium is CO_2, and two machines, Fig. 9, have been installed to carry the present load. One is rated at 120 tons and the other at 60 tons. The foundation has been laid for a third machine of 120 tons' capacity, which will be installed when the second section of the hotel has been completed. Both of the compressors are directly driven by Corliss engines making 65 r.p.m. The large machine is used principally for air cooling, while the smaller compressor serves the refrigerating and ice-making load. For both machines the condenser pressure runs close to 65 atmospheres, while the suction pressures are 30 atmospheres for the large machine and 18 to 20 for the 60-ton unit. The piping is so cross-connected, however, that either machine may supply either service.

At present the bunker coils in the ventilating system have a capacity to absorb 120 tons of refrigeration, thus taking the full capacity of the large machine. The coils are made up of 1¼-in. pipe, and about 45 lin.ft. are allowed per ton. They are proportioned to cool the air to 60 deg. in the bunkers, so that it will reach the various rooms at a temperature close to 70 deg. Refrigeration is effected by direct expansion and the same system has been adopted for cooling the drinking water and ice making.

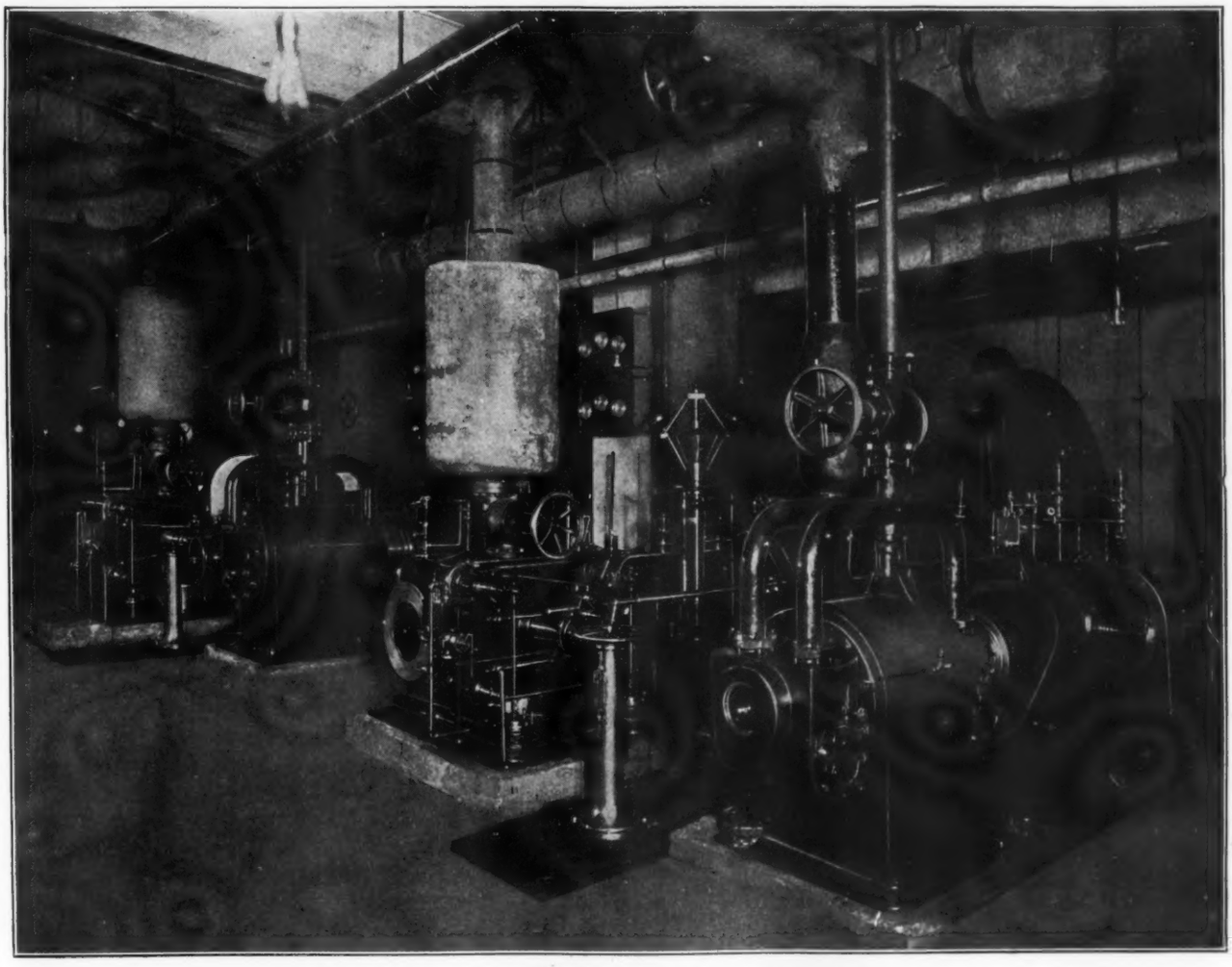


FIG. 9. TWO ENGINE-DRIVEN CARBON DIOXIDE COMPRESSORS

The condenser, Fig. 10, is of the double-pipe type made up of 15 sections 20 ft. long and 14 pipes high. The inner pipe is 1¼ in. and the outer 2 in. in diameter. Cooling water comes from the city mains. After passing through sand filters it enters a surge tank. The suction of the circulating pump is connected to the bottom of

this tank and after passing through the condenser the water is returned to the upper part of the same tank. As the house water-supply is drawn from this tank the warm water from the condenser is rapidly taken off and a cool supply is maintained at the bottom of the tank. Should the temperature exceed a certain point a

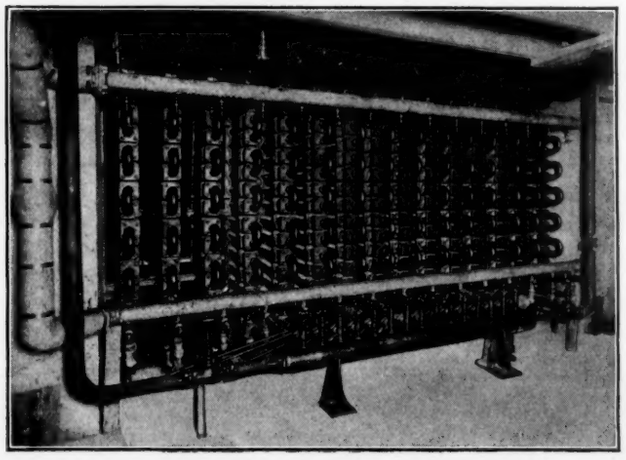


FIG. 10. THE DOUBLE-PIPE CO_2 CONDENSER

thermostatic valve will discharge the contents of the tank to the sewer.

Brine at 10 deg. F. is circulated to the various refrigerators. A 65-ton double-pipe brine cooler and the brine tank have been surrounded by a self-supporting cork housing made up of two layers of 2-in. cork board lined with 7/8-in. board. The floor has two layers of cork board covered by 1 in. of asphaltum. The brine cooler is made up of five sections 20 ft. long and 12 pipes high, the pipe diameters being 1¼ and 2½ in. respectively. Each of the three centrifugal pumps, Fig. 11, circulating the brine is rated at 250 gal. per min. One was intended to transfer the brine from the tank to the cooler, and the other two are house pumps installed in duplicate to work against a pressure of 110 lb. These pumps, which are driven by 20-hp. motors, circulate the brine to the

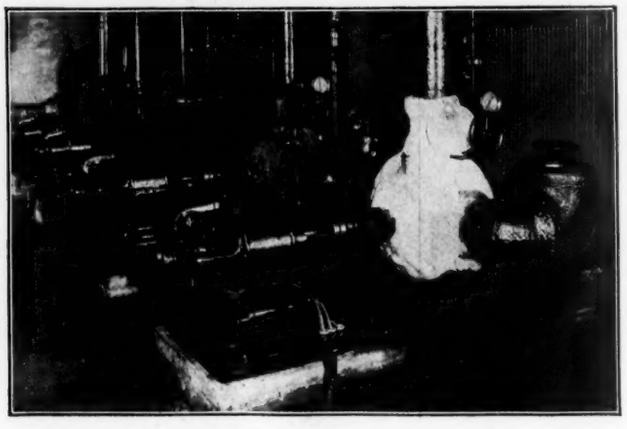


FIG. 11. THREE BRINE PUMPS AND ONE CONDENSER WATER PUMP

various refrigerators. By allowing the returns to flow through the cooler by gravity to the brine tank, it has been possible to operate the system on one pump.

The ice tank, which is to be installed shortly, will be equipped with 216 one-hundred-pound cans in which water will freeze in 15 to 24 hr. Condensation from kitchen and laundry equipment, and perhaps other sources, will furnish plenty of distilled water. The temperature of this condensed steam will first be lowered in a double-pipe cooler 12 ft. long, 6 pipes high, 1¼-2½-in. pipes. Water from the city mains will pass through this cooler and be returned to the surge tank. The condensation will then pass to a fore-cooling tank equipped with 120 ft. of 1¼-in. pipe through which the return gas of the refrigerating system will pass and lower the temperature of the condensation to about 35 deg. F., so that when it enters the cans the temperature will be within 3 deg. of the freezing point.

Drinking water is cooled in a glass-enameled steel tank provided with a 20-ton cooling coil which lowers the temperature of the drinking water to 40 deg. F. The return water comes back at 45 deg., and the makeup, which is drawn from the city mains and filtered, will range in temperature from 55 to 60 deg. Every room

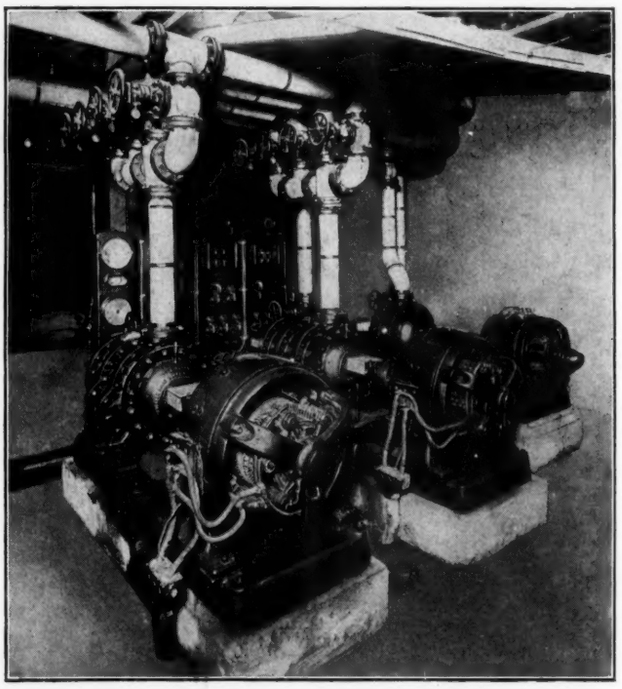


FIG. 12. EIGHT-STAGE AND FOUR-STAGE HOUSE-SERVICE REFRIGERATION PUMPS

in the hotel has running ice-water which is circulated by a triplex gearless pump having a capacity of 40 gal. per min.

The water piping for house service has been divided into three sections. From the first floor down service is maintained by city pressure. From the first to the tenth floor the system is equipped with two closed hydropneumatic tanks located in the basement. The pressure maintained is approximately 100 lb. The high-pressure system (150-175 lb.) serving the tenth to the twenty-second floor is provided with two open tanks under float control. There is also a standpipe for fire service. In the latter water is maintained at a constant pressure by an eight-stage centrifugal pump driven by a 50-hp. motor. A unit of the same type and capacity serves the high-pressure open-tank system and the four-stage pump, driven by a 25-hp. motor, Fig. 12, serves the low-pressure closed-tank system. The pumps are interconnected from the water end, as shown in Fig. 13, so that any one may be used on either of the three systems, or if need be,

for boiler feeding. Each pump is controlled by a pilot device. For the low-pressure tanks in the basement and the standpipe this consists of a panel carrying an electric pressure gage and a pressure-gage relay. The pilot device for the open tanks on the roof consists of a float switch with a float, chains, weights and other usual parts.

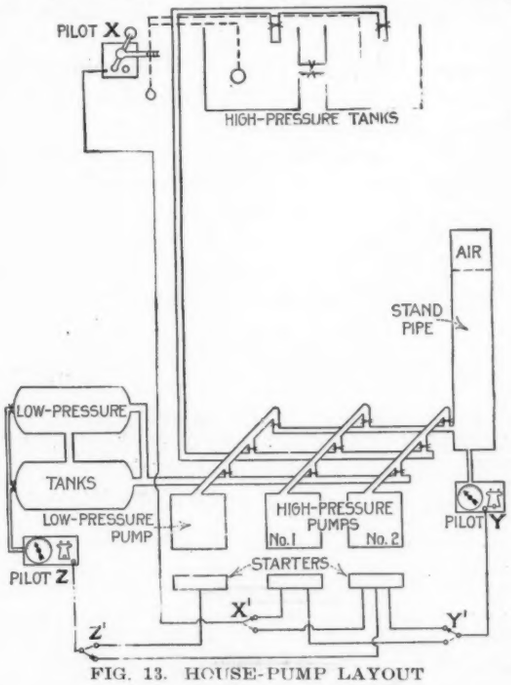


FIG. 13. HOUSE-PUMP LAYOUT

It was desired that the equipment be furnished with a transfer device that would give four operating combinations, these to be so laid out that it would be impossible to connect more than one pilot device to any one self-starter in any single position. This was accomplished by the dial-type transfer switch shown in Fig. 14 at the center of the right-hand panel. The

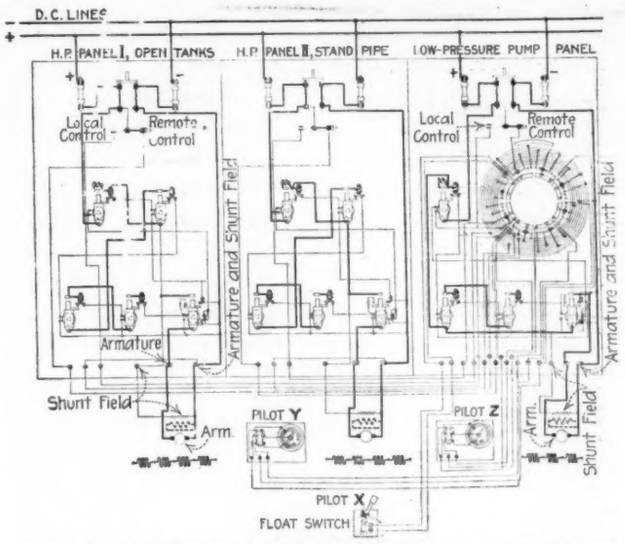


FIG. 14. DIAGRAM OF THE ELECTRICAL CONTROL OF THE HOUSE PUMPS

pumps are connected to three headers in the basement by means of valves, and when the transfer switch on the board is set for a given position, valve settings are made to correspond. To avoid mistakes, the valves are tagged and an instruction sheet is posted for reference. The general method of operation will be apparent from Fig. 13, which shows the three headers and the supply lines from the pumps. The water pipes are shown in double lines, the pilot connections for the various self-starters by single lines, and the valves are indicated by crosses. The switching mechanism has been so worked out as to obtain the following combinations corresponding to the various positions of the transfer switch:

Transfer-Switch Position	Pilot Devices		
	X	Y	Z
A	H.P.—1	H.P.—2	L.P.
B	Dead	H.P.—1	H.P.—2
C	H.P.—2	H.P.—1	L.P.
D	H.P.—1	Dead	H.P.—2

In the table the designations H.P. and L.P. stand for high-pressure and low-pressure pumps and the letters *X*, *Y* and *Z* indicate the particular style of device operating the pumps. These designations correspond to those used in Figs. 13 and 14.

The high-pressure open tanks have been installed in duplicate, so that one may be maintained in operation

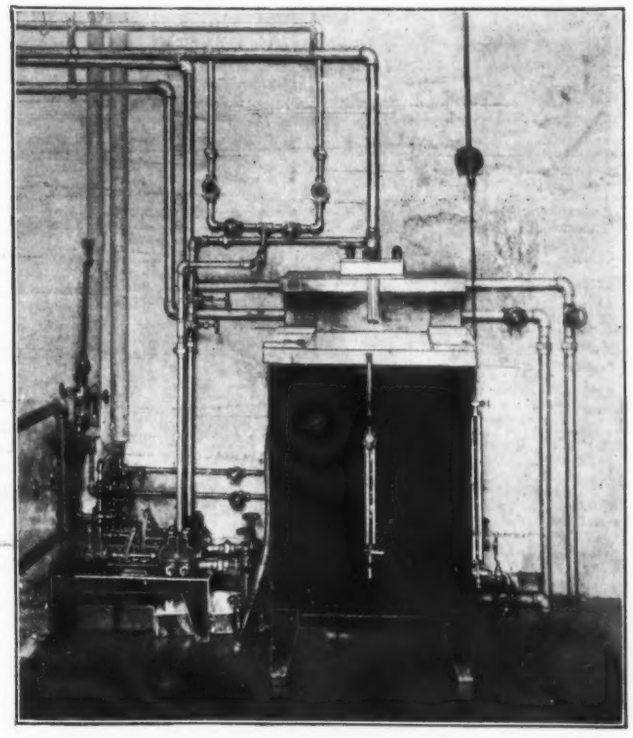


FIG. 15. OIL FILTER AND PUMPS

while the other is being cleaned. They have two sets of accessories and one float switch. When it is desired to clean one tank, the valve between the two and the valve in the pipe discharging to the tank to be cleaned are closed and the float chains are adjusted to correspond. Ordinarily, the two tanks work in parallel on one float.

Oiling-System Details

Lubrication of the main generating and refrigerating units is effected by two complete systems, one for cylinder oil and the other for engine oil. Clean oil is stored in two 250-gal. overhead tanks, one for each system. From one of the tanks clean engine oil flows by gravity to the distributing piping under the engine-room floor. A separate riser with a valve for each engine conveys the clean oil to the distributing points. After passing through the bearings the used oil from the various units flows by gravity to a drain tank located in a tunnel under

the floor. This drain tank is furnished with an automatic pump governor consisting of a globe valve operated by means of a float and counterbalance weight. When the dirty oil rises to a predetermined point in the tank the governor opens the valve admitting steam to two duplex pumps located beside the filter, Fig. 15. One of these pumps transfers the dirty oil from the drain tank into the filter, while the other, taking its suction from the clean-oil compartment of the filter, elevates the clean oil to the overhead storage tank ready for re-use.

All points of lubrication on the engine are provided with four-window sight-feed oilers with 5-oz. reserve cups on top. Normally the latter are kept closed, but should connection from the overhead cylinder-oil storage tank, so that it is automatically kept full of oil.

A polished-brass oil wall sink is provided with two faucets. One of these is connected with the cylinder-oil system and the other to the bearing oil, so that the engineer can draw off a small quantity of either kind of oil. The drip tray has a divided wall so that the two kinds will not become mixed. The drips from the bearing-oil side are connected to the dirty-oil drain piping under the floor, but the cylinder-oil side is not drained, as it is important not to mix the two oils.

The two duplex steam oil pumps are so cross-connected that either can be used for pumping the dirty or clean

PRINCIPAL EQUIPMENT OF NEW MORRISON HOTEL PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Boilers	Horizontal water-tube	500-hp.	Generate steam	Op. press. 160 lb., natural draft, stokers	Edge Moor Iron Co.
3	Stokers	Chain-grate	100 sq.ft.	Serve boilers	Driven by engine or motor	Illinois Stoker Co.
1	Stack	Oval, steel	6x9 ft., 325 ft. high	Serve boilers		Lasker Iron Works
3	Soot blowers			Serve boilers		Vulcan Iron Works
1	Ash-handling system	Vacuum, steam jet	8-in. pipe, 4 tons per hr.	Ashes from pit to tank		Griffin Engineering Works
1	Weigh hopper	Traveling		Coal from bunker to stokers		Howe Scale Co.
2	Pumps	Duplex	12x7x12-in.	Boiler feed		Warren Steam Pump Co.
2	Heaters	Open	750-hp.	Heat boiler feed	Exhaust steam	John E. Angells & Co.
3	Heaters	Closed	5000 gal. per hr.	Hot water, house service	Exhaust steam	Alberger Condenser Co.
3	Oil separators	Horizontal and vertical	One 24-in., two 18-in.	Remove oil from exhaust steam		John E. Angells & Co.
15	Traps	High-pressure, bucket		Return clean drips		Kieley & Mueller
2	Engines	Simple Corliss	22x32-in.	Main generating units	160 lb. steam. 150 r.p.m.	Providence Engineering Works
2	Generators	Three-wire, inter-pole	400-kw.	Main generating units	110-220 volts, 150 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Engine	Simple Corliss	16x30-in.	Main generating units	160 lb. steam, 150 r.p.m.	Providence Engineering Works
1	Generator	Three-wire, inter-pole	200-kw.	Main generating units	110-220 volts, 150 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Compressor	CO_2	120-ton	Air cooling	65 to 30 atmospheres	American Carbonic Machinery Co.
1	Engine	Simple Corliss	18x36-in.	Drive 120-ton compressor	160 lb. steam, 65 r.p.m.	Filer & Stowell Co.
1	Compressor	CO_2	60-ton	Refrigerating and ice making	65 to 20 atmospheres	American Carbonic Machinery Co.
1	Engine	Simple Corliss	14x30-in.	Drive 60-ton compressor	160 lb. steam, 65 r.p.m.	Filer & Stowell Co.
21	Condensers	Double-pipe	15 sections, 20 ft. long, 14 pipes high	Condense CO_2 gas	Pressure 65 atmospheres	American Carbonic Machinery Co.
1	Pump	Centrifugal	250 gal. per min.	Circulate cooling water	Driven by 5-hp. Westinghouse motor, 1800 r.p.m.	Manistee Iron Works Co.
1	Brine cooler	Double-pipe	5 sec., 20 ft. long, 12 pipes high	Cool brine for refrigeration	10-deg. brine	American Carbonic Machinery Co.
3	Pumps	Centrifugal	250 gal. per min.	Circulate brine	Driven by Westinghouse motors, 5 and 20 hp.	Manistee Iron Works Co.
1	Ice tank	Distilled water	10-ton	Make ice	Direct expansion, 15-24 hr.	American Carbonic Machinery Co.
1	Cooler	Glass enameled steel	20-ton coil	Cool drinking water	40 deg. F.	American Carbonic Machinery Co.
1	Pump	Triplex gearless	40 gal. per min.	Circulate drinking water	Belt driven by 5-hp. R. E. motor, 375 r.p.m.	Henion & Hubbell
2	Filters	Disk	24-in. diam.	Filter drinking water		International Filter Co.
2	Filters	Quartz	8000 gal. per hr.	Filter city water		International Filter Co.
2	Oiling systems	Central	100-200 gal. per hr.	For bearings and cylinders		Richardson-Phenix Co.
2	Pumps	3-stage, centrifugal	250 gal. per min.	House water and fire service	Driven by 50-hp. Westinghouse motor	Manistee Iron Works Co.
1	Pump	4-stage centrifugal	250 gal. per min.	House water	Driven by 25-hp. Westinghouse motor	Manistee Iron Works Co.
	Controllers	Electric		House-pump motors and all motors in plant		Cutter Hammer Co.
7	Elevators	Helical-gear traction	3000-lb.	Passenger and service	550 and 400 ft. per min.	Otis Elevator Co.
1	Elevator	Worm-gear traction	4000-lb.	Freight	150 ft. per min.	Otis Elevator Co.
11	Fans	Multi-vane	307,800 cu.ft. per min. total	Ventilation		B. F. Sturtevant Co.
11	Motors	Direct-current, 220 volts	216 hp. total	Drive fans		Sprague Electric Works
3	Air washers		96,000 cu.ft. per min. total	Wash air for building	Humidity control on all, temperature control on two	Iroquois Engineering Co.
1	Air compressor	Single-stage	16x10-in.	Pneumatic-tube system	Driven by 30-hp. Westinghouse motor	Clayton Air Compressor Works
1	Pump	Vacuum	6 tools	Vacuum cleaning	Driven by 7½-hp. Westinghouse motor	Palm Vacuum Cleaner Co.
1	Fire-alarm system			Fire-alarm and watchman service		McFell Signal Co.

anything happen to the system they can be immediately turned on and will furnish lubrication for a considerable length of time. The eccentric and crosshead pins are lubricated by telescopic oilers. All piping at the engine is nickel-plated.

Each of the main units is equipped with a three-feed cylinder lubricator, one feed being inserted in the steam line and one running to each of the inlet valves. Each lubricator is provided with a float valve and a pipe oil, and they are also furnished with a flexible hose connection so that they can be used for pumping oil out of the barrels to either the bearing or cylinder-oil storage tanks. Sight-flow indicators in the discharge lines of the pumps show whether or not the oil is flowing properly.

The first section of the hotel is equipped with eight elevators. Seven are of the helical-gear traction type, the first installation of the kind in the city, and one of

the worm-gear traction type, the latter being operated by push-buttons. Of the former five are passenger elevators having a capacity of 3000 lb. each. The other two are service elevators. Two of the passenger cars are equipped with 34-hp. motors and travel at 550 ft. per min. The rest are driven by 26-hp. motors at a speed of 400 ft. per min. The push-button elevator has a 24-hp. motor, a speed of 150 ft. per min., and a capacity of 4000 lb.

For conveying orders between the engine room, office and stations on each floor a pressure pneumatic-tube system has been installed. It consists of a 16x10-in. air compressor, belt-driven by a 30-hp., automatically controlled motor. From the compressor the air is forced into a 100-cu.ft. tank at 15 lb. pressure. Through a reducing valve set for 5 lb. pressure it passes into a second tank of the same capacity, and from here it is piped to each station. When the pressure drops below 5 lb. a contact pin on a pressure gage closes the circuit and starts the compressor motor. The other contact pin is set at 15 lb., and when the pressure in the first tank reaches this limit the compressor is automatically stopped. It is thus evident that the compressor only operates at intervals, depending

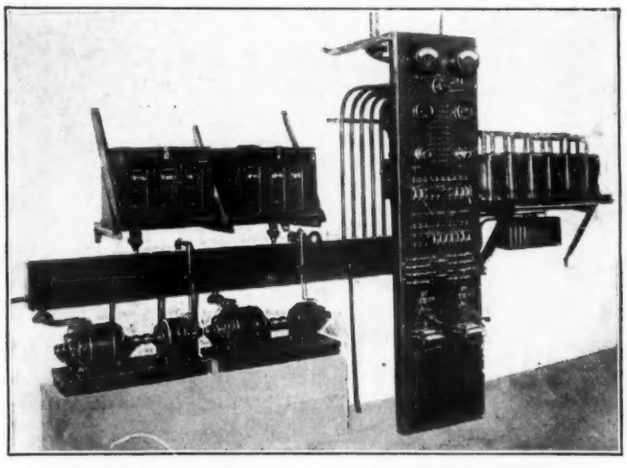


FIG. 16. SPECIAL EQUIPMENT FOR FIRE-ALARM AND VARIOUS SIGNAL SERVICES

on the frequency with which the pneumatic-tube system is used.

For vacuum cleaning a motor-operated vacuum pump designed for six tools is kept in constant service. A vacuum of 5 to 11 in. is maintained, depending on the number of tools in service. The water flow to the machine is under governor control. Electric and pneumatic ejectors, automatically controlled, raise the sewage. A telautograph is in service between the engine room and all departments, and an unusually complete combination fire-alarm and watchman's-service system, Fig. 16, has just been completed. The two systems are operated on the same circuit, and one service does not interfere with the other. Each watchman is provided with a key which, when inserted in any call box and given a quarter turn, will record the box number once on the time clock. In case a fire alarm is turned in from any of these boxes, the watchman's service is automatically cut out while the alarm is going in. The same record wheel is used for both services. When the watchman records the box number once on the clock dial, the fire-alarm call will be recorded three times on the tape register and sounded three times on all of the electro-mechanical gongs connected with this system. The alarm will be received from any or all of the call boxes, even if one or both of the main-box circuit wires are broken or short-circuited.

In case of a broken wire, short-circuit or any defect in the apparatus, the trouble is made evident at the switchboard by the lighting of two red trouble lamps and the ringing of the trouble bell. It is then necessary to throw in a switch and use the reverse feed until the trouble is remedied. The two motor-generators, storage battery and switchboard used in connection with this system are shown in Fig. 16. Other features are a Sohm electric time-clock and stamp system, with stamping devices in all departments and at all floor stations, and Diamond H door switches to turn off all lights in the rooms when the doors are locked from the outside.

Marshall & Fox, of Chicago, were the architects and engineers for the building and power plant. Mehring & Hanson installed the heating and ventilating systems and the power piping. All work was done under the supervision of Alfred P. Roemer, chief engineer of the power plant.

Rules for Thickness of Cast-Iron Pipes

In calculating the thickness of cast-iron pipes, allowance must be made for the core being slightly out of the center and the sagging of long cores, as the strength of the pipe depends upon the thinnest part. The factor of safety given ought to be 10, although many engineers employ 8, and some only 6. The thickness, except for very small pipes, should not be less than one-half inch for any pressure.

All pipes should be carefully tested up to double the working pressure, although three or four times the working pressure is sometimes specified; this appears to be putting an undue strain on the metal. During the test each pipe should be tapped all over with a hammer to detect blow-holes, or, as some term them, air-bubbles.

The resistance which a pipe offers to the internal pressure tending to burst it is equal to the tensile strength of its two sides, and the effective area of that pressure is the internal diameter times its length. If we take the tensile strength of cast iron as 15,000 lb. per sq.in., the thickness of a pipe will be found by the formula,

$$T = \frac{0.433 \times H \times R}{15{,}000} = 0.0000288 \times H \times R;$$

in which

H = The head of water in feet;
R = The radius of the pipe in inches;
T = Thickness of metal in inches and fractions of an inch;
0.433 = The pressure of a column of water one foot high;
15,000 = Tensile strength of cast iron in pounds per square inch.

When D = diameter of pipe in inches, the formula becomes

$$T = 0.0000144 \times H \times D$$

and if we use a factor of safety of 10 we get

$$T = 0.000144 \times H \times D$$

If the pressure is given in pounds per square inch, the following formula may be used:

$$T = (0.000125 \times P \times D) + C$$

in which

P = Pounds per square inch;
C = A coefficient = 0.37 in. for pipes less than 12 in. diameter; 0.5 in. for pipes from 12 to 30 in. diameter; 0.6 in. for pipes from 30 to 50 in. diameter.

Anchoring—All pressure piping, especially if its temperature varies through a considerable range, should be securely anchored or fixed to prevent displacement in the direction of its length, at a point approximately midway between expansion sections. This may be done by a clamp at a fixed supporting bracket or by parallel or slightly radial stay-rods, or braces, from a clamp or rigid attachment on the pipe to fixed points in the building. Clamps fixed at flanges or fittings are less likely to slip under strain.

Rewinding Direct-Current Motors and Generators--II

By A. A. Fredericks

SYNOPSIS—The necessary armature and field changes in adapting a 120-volt machine to 240 volts, or vice versa.

Let it be required to change the windings on a 4-pole, 120-volt machine for 240 volts, the speed to remain the same. In this case, since the voltage is doubled it will be necessary to double the number of conductors in series in the armature winding. If the armature winding is parallel-connected, as shown in Fig. 9, this condition may be satisfied by connecting it in series, as in Fig. 10. In the former there are four circuits in parallel, that is, four paths for the current to flow from the positive terminal, in the case of a motor; and in the latter there are only two circuits in parallel. Consequently, there are twice as many conductors in series in Fig. 10 as in Fig. 9, also in the series-connected winding brushes B_1 and B_2, or B_3 and B_4 may be dispensed with and the machine will still work satisfactorily.

In Fig. 10 coil 16 has been left out of circuit. This is necessary, as a 4-pole armature winding having an even number of coils cannot be connected series, and come out without any left over. This difficulty can always be overcome by leaving one coil dead and connecting two of the commutator segments, as 17 and 18.

As referred to in Part 1 (July 20 issue) an armature winding to be connected in series must have a number of coils to meet the requirements of the formula, $C = \frac{PS}{2} \pm 1$, where C is the number of coils, p the number of poles and S the pitch of the winding measured in the number of segments spanned by the leads of one coil. Applying this formula to the winding in Fig. 10,

$$C = \frac{PS}{2} \pm 1 = \frac{4 \times 11}{2} \pm 1 = 23 \text{ or } 21$$

Therefore, 23 active coils meet the requirements.

Inasmuch as the machine is being changed so as to work on double the voltage for which it was designed,

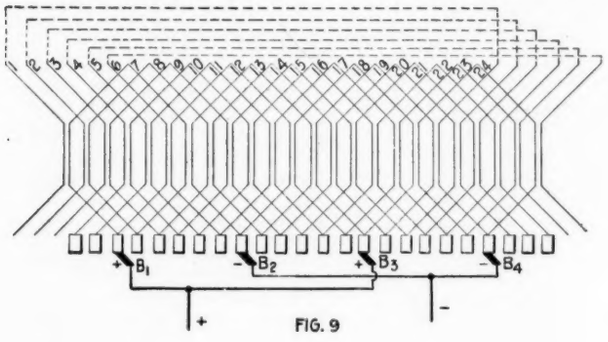


FIG. 9

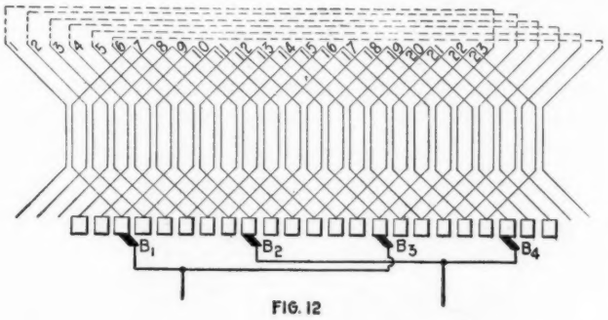


FIG. 12

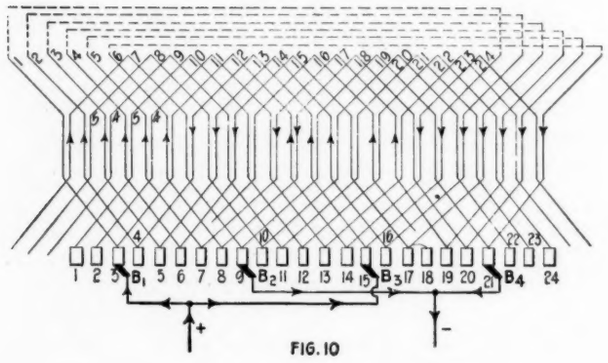


FIG. 10

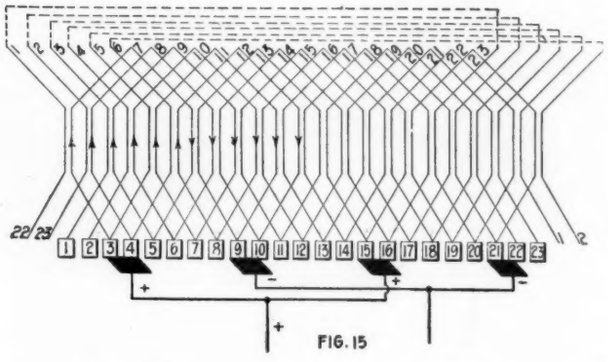


FIG. 15

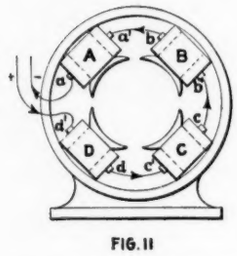


FIG. 11

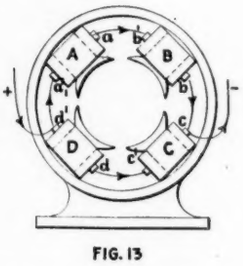


FIG. 13

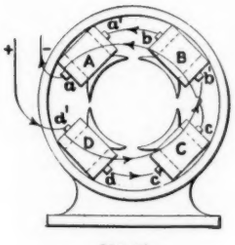


FIG. 14

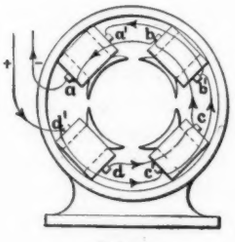


FIG. 16

FIGS. 9 TO 16. ILLUSTRATING HOW TO CHANGE THE VOLTAGE BY ALTERING THE ARMATURE WINDING OR FIELD CONNECTIONS

the field winding should if possible, meet this condition with the same amount of energy used as before. All machines have their field coils designed to be connected in series; therefore consider this the condition in this problem, as shown in Fig. 11. Since the voltage has been doubled, the resistance of the field coils will also have to be increased. On first thought it may seem that doubling the resistance when the voltage is doubled would be proper, but this is not true. The rule for properly solving this problem is: *The resistance of a coil of given weight must be varied as the square of the voltage applied, if the energy expended in the coil is to be constant.* Therefore, if the voltage is increased by 2 the resistance of the field coil will have to be increased by 4; in other words, if the resistance of the 120-volt field coils is 250 ohms, for the same machine to work on 240 volts the field-coil resistance will have to be 250 × 4, or 1000 ohms.

This problem is easily solved by keeping in mind that for a coil of given weight the resistance varies inversely as the square of the cross-sectional areas of the conductors; consequently, if the cross-sectional area of a given conductor is reduced by 2 (the weight remaining the same) its resistance is increased 4 times. For example, from the wire table it will be found that the resistance of 1 lb. of bare No. 14 B. & S. copper wire at 68 deg. F. is 0.203+ ohm. The cross-sectional area is 4107 circ.mils. A No. 17 B. & S. wire has a cross-sectional area approximately one-half that of a No. 14, or 2048 circ.mils, but the resistance of 1 lb. of No. 17 is not twice that of 1 lb. of No. 14, but 4 times, or 0.2028 × 4 = 0.8112 ohm against 0.8153 given in the wire table.

Since the resistance of a coil of given weight must vary as the square of the voltage applied, to maintain a constant expenditure of energy in the coil, it follows that if the voltage is doubled the resistance must be increased by four; and since the resistance of a given weight of copper varies inversely as the square of the cross-sectional area, then if the applied voltage is increased by two the cross-sectional area of the conductor must be decreased by two. For example, on the 120-volt machine assume that each one of the four field coils contains 7½ lb. of No. 22 B. & S. single cotton-covered wire, then the total weight of wire in the field coils is 7½ × 4 = 30 lb. The resistance of 1 lb. of No. 22 single cotton-covered wire is 7.941 ohms, then the total resistance of the field coils is 7.941 × 30 = 238.23 ohms. The current flowing through the field coils is

$$I = \frac{E}{R} = \frac{120}{238.23} = 0.504 \text{ amp.}$$

and the energy expended in the coils is

$$W = EI = 120 \times 0.504 = 60.48 \text{ watts}$$

Furthermore, assume that the average length per turn in the field coils is 2 ft. One pound of No. 22 single cotton-covered wire contains 492 ft., and 30 lb. contains 492 × 30 = 14,760 ft., which is the total length of wire in the four field coils. Since the length of the average turn per coil is 2 ft., the total number of turns on the four coils will be $\frac{14,760}{2} = 7380$ turns, and the total ampere-turns will be the current in amperes multiplied by the total turns in series, or 0.504 × 7380 = 3720 ampere-turns. This is the condition to be met in the 240-volt field windings, namely, 60.48 watts expended in the field coils producing 3720 ampere-turns.

According to the foregoing, rewinding the field coils with the same weight of wire of one-half the cross-section of that used on the 120-volt field winding would meet the 240-volt requirements. From the wire table it will be seen that a No. 25 wire has one-half the cross-section of a No. 22, and that the resistance per pound of No. 25 single cotton-covered wire is 31.07 ohms, or approximately 4 times that of No. 22 single cotton-covered wire. Then the total resistance of the field coils wound with 30

WIRE TABLE

Size B. & S. Gage	Area in Circular Mils	Diameter in Mils 1 Mil = 0.001 In.	Ohms per 1000 Ft. at 68 deg. F.	Bare Copper: Pounds per 1000 Ft.	Bare Copper: Feet per Pound	Bare Copper: Ohms per Pound	Single Cotton-Covered: Outside Diameter, In.	Single Cotton-Covered: Feet per Pound	Single Cotton-Covered: Ohms per Pound	Double Cotton-Covered: Outside Diameter, In.	Double Cotton-Covered: Feet per Pound	Double Cotton-Covered: Ohms per Pound
0	105534	324.86	0.098	319.5	3.130	0.000307	0.333	3.1	0.000305	0.339	0.1	0.000304
1	83693	289.29	0.124	253.3	3.947	0.000488	0.297	3.9	0.000487	0.303	3.9	0.000484
2	66371	257.63	0.156	200.9	4.977	0.000776	0.266	5.0	0.000772	0.272	4.9	0.000768
3	52634	229.42	0.197	159.3	6.276	0.00124	0.237	6.2	0.00123	0.243	6.2	0.00122
4	41741	204.31	0.248	126.4	7.914	0.00196	0.212	7.8	0.00195	0.218	7.8	0.00194
5	33102	181.94	0.313	100.2	9.980	0.00312	0.190	9.9	0.00310	0.196	9.9	0.00308
6	26251	162.02	0.394	79.46	12.58	0.00496	0.170	12.5	0.00492	0.176	12.4	0.00489
7	20818	144.28	0.497	63.02	15.87	0.00789	0.152	15.7	0.00780	0.158	15.6	0.00775
8	16510	128.49	0.627	49.98	20.01	0.01255	0.136	19.8	0.0124	0.142	19.6	0.0123
9	13093	114.43	0.791	39.63	25.23	0.01995	0.121	24.9	0.0198	0.125	24.7	0.0196
10	10383	101.90	1.000	31.43	31.82	0.03173	0.108	31.4	0.0314	0.113	31.1	0.0311
11	8234	90.74	1.257	24.93	40.12	0.05045	0.097	39.5	0.0497	0.102	39.1	0.0493
12	6530	80.81	1.586	19.77	50.59	0.08022	0.087	49.6	0.0786	0.092	49.2	0.0781
13	5178	71.96	1.999	15.68	63.79	0.1276	0.078	62.5	0.125	0.083	61.7	0.123
14	4107	64.08	2.521	12.43	80.47	0.2028	0.070	78.6	0.198	0.075	77.5	0.195
15	3257	57.07	3.179	9.86	101.40	0.3225	0.063	98.9	0.315	0.068	97.0	0.309
16	2583	50.82	4.009	7.82	127.9	0.5128	0.056	125	0.502	0.060	122	0.492
17	2048	45.26	5.055	6.20	161.3	0.8153	0.050	157	0.795	0.054	153	0.776
18	1624	40.30	6.374	4.92	203.4	1.296	0.045	198	1.263	0.050	192	1.228
19	1288	35.89	8.038	3.90	256.5	2.061	0.041	248	1.985	0.045	240	1.936
20	1022	31.96	10.140	3.09	323.4	3.278	0.0365	311	3.149	0.0410	300	3.045
21	810	26.46	12.780	2.45	407.8	5.212	0.0330	389	4.968	0.0375	376	4.804
22	642	25.35	16.120	1.94	514.2	8.287	0.0298	492	7.941	0.0343	473	7.604
23	509	22.57	20.320	1.54	648.4	13.18	0.0271	613	12.47	0.0316	588	11.95
24	404	20.10	25.630	1.22	817.6	20.95	0.0246	769	19.70	0.0291	729	18.71
25	320	17.90	32.310	0.970	1031	33.32	0.0224	961	31.07	0.0269	900	29.11
26	254	15.94	40.750	0.760	1300	52.97	0.0204	1217	49.57	0.0249	1114	45.38
27	201	14.20	51.380	0.610	1639	84.23	0.0187	1510	77.46	0.0232	1370	70.30
28	160	12.64	64.790	0.484	2067	133.90	0.0171	1900	123.17	0.0216	1700	110.18
29	127	11.26	81.700	0.384	2607	213.04	0.0158	2336	190.88	0.0203	2060	168.45
30	100.5	10.02	103.000	0.304	3287	338.65	0.0140	2967	305.63	0.0190	2611	268.81
31	79.7	8.93	129.900	0.241	4145	538.47	0.0129	3650	474.09	0.0179	3144	408.48
32	63.2	7.95	163.800	0.191	5227	856.24	0.0120	4504	737.84	0.0169	3788	620.45
33	50.1	7.08	206.6	0.152	6591	1361.36	0.0111	5525	1141.42	0.0160	4520	934.84
34	39.7	6.30	260.5	0.120	8311	2165.7	0.0103	6756	1760.1	0.0153	5376	1401.1
35	31.5	5.61	328.4	0.0954	10482	3441.3	0.0096	8197	2691.8	0.0141	6803	2234.0
36	25.0	5.00	414.2	0.0757	13217	5473.0	0.0090	9901	4100.9	0.0135	7937	3287.6
37	19.8	4.45	522.2	0.0600	16666	8702.4	0.0084	12500	6527.5	0.0129	9174	4790.8
38	15.7	3.96	658.5	0.0476	21015	13870.6	0.0079	15151	9977.3	0.0119	11310	7449.1
39	12.5	3.53	830.4	0.0377	26500	22000.1	0.0075	17857	14821.6	0.0115	13120	10896.3
40	9.9	3.14	1047.0	0.0299	33416	34980.5	0.0071	20833	21812.5	0.0111	15037	15744.4

lb. of No. 25 is $31.07 \times 30 = 932$ ohms. The current flowing in the 240-volt field coils is $I = \frac{E}{R} = \frac{240}{932} = 0.258$ amp. The watts, $W = EI = 240 \times 0.258 = 61.92$ watts, which is approximately the same as for the 120-volt machine.

One pound of No. 25 single cotton-covered wire contains 961 ft.; then 30 lb. will contain $961 \times 30 = 28{,}830$ ft. The average length per turn will be approximately the same in the 240-volt field coils as in the 120-volt, namely, 2 ft. Then the total turns on the 240-volt field coils will equal the total length in feet divided by the average length per turn $= \frac{28{,}830}{2} = 14{,}415$ turns, and the total ampere-turns will be $14{,}415 \times 0.258 = 3719$. This is only one ampere-turn less than on the 120-volt field coil; consequently, *to rewind the field coils for double their original voltage all that is necessary is to divide the cross-section of the wire used in the low-voltage winding by 2 and rewind with the same weight of the smaller wire.* If the voltage is increased by 4, as from 125 to 500 volts the field coils will have to be rewound with the same weight of wire of one-fourth the cross-section.

If the conditions to be met were opposite to those in the foregoing problem, that is, changing the machine from 240 volts to 120 volts or 500 to 250 volts, and the armature were series-connected as in Fig. 10, it would be necessary to connect the winding in parallel as in Fig. 9. In all probabilities, if the winding were series-connected it would contain an uneven number of coils, but this would not alter the situation, for any number of coils can be used in a parallel-connected winding; see Fig. 12, which has only 23 coils, but is connected the same as that in Fig. 9. Another feature that would have to be considered in this case would be the brushes. If the armature is series-connected on a small-sized 4-pole machine it is likely that there would be only two brushes on the commutator. In a 4-pole, parallel-connected winding four brushes are required; consequently, if the armature is series-wound and has only two groups of brushes, if it is changed to parallel-connected it will be necessary to obtain a rocker arm that will accommodate four groups of brushes, and two more groups of brushholders. These can usually be obtained from the manufacturers, unless the machine is of an obsolete type.

When rewinding a motor or generator for a lower voltage the field coils can usually be so regrouped that they will meet the new condition without rewinding—for instance, changing a 500-volt, 4-pole machine to 250 volts, or a 4-pole, 240-volt machine to 120 volts. In the original field winding the coils will always be connected in series, as in Fig. 11. Connecting the field coils in series-parallel, as in Fig. 13, will produce the same conditions of field strength on a 250-volt, or a 120-volt circuit as series-connected coils on 500,- or 240-volt circuits, respectively. To make this clear assume each field coil of Fig. 11 to contain 1500 turns and have a resistance of 250 ohms. The total resistance is the resistance per coil multiplied by the number of coils in series, or $250 \times 4 = 1000$ ohms.

The current set up in the coils on a 500-volt circuit, is $I = \frac{E}{R} = \frac{500}{1000} = 0.5$ amp. The ampere-turns per coil are $0.5 \times 1500 = 750$. The energy expended is $EI = 500 \times 0.5 = 250$ watts. If the field coils are connected series-multiple, as in Fig. 13, and are connected on a 250-volt circuit, the conditions will be the same as for 500 volts with the coils connected in series. Where the coils are connected series-multiple there are two circuits with two coils in series in each circuit, and the resistance of each group will be equal to the number of coils in series per group multiplied by the resistance per coil, or $2 \times 250 = 500$ ohms, and the current per path will be $I = \frac{E}{R} = \frac{250}{500} = 0.5$ amp. The ampere-turns per coil are $0.5 \times 1500 = 750$. The total current I is the sum of the current in each path, or $0.5 + 0.5 = 1$ amp. The total energy expended in the field coils is $EI = 250 \times 1 = 250$ watts, which is the same as on the 500-volt circuit. This also holds true for any case where the voltage is cut in half.

In making the series-parallel connections, as in Fig. 13, it will be necessary to revolve coils A and B or C and D through one-half turn to maintain the proper polarity, for the current is reversed in coils A and B in Fig. 13 from that in Fig. 11. The lettering on the coil terminals illustrates the necessary changes to be made. The series-parallel connection could be made as in Fig. 14 without moving the field coils, but the method in Fig. 13 is preferred, especially for neatness.

Another condition would be to rewind a 500-volt machine for 125 volts. If the machine has four poles with the armature series-connected, the conditions can be met by connecting the armature winding in double-parallel, as in Fig. 15; it will then be necessary to use brushes thick enough to span at least two segments and a group of brushes for each pole. The field coils may be made to meet the 125-volt requirements by connecting them in parallel, as in Fig. 16.

Maintenance of Insulation for Low Temperatures

By R. L. Shipman

A condition that seems to need a more general and thorough understanding is the commercial impossibility of avoiding changes in the air content of practically all insulating walls. These walls undergo what may be called a breathing process, in which air is continually passing in or out of the body of the insulation.

This breathing action is due to two causes—the change in barometric pressure and the change of temperature. The change in barometric pressure alone may produce a change of 4 to 6 per cent. of the air content in a few hours, while an average change of 3 to 5 per cent. of the air content due to this cause is commonly a daily occurrence. The change in air content due to change in temperature may run as high as 10 per cent. or more in a day, especially in walls upon which the heat of the sun has free play, and a change of several per cent. is a daily occurrence. When these two effects are added, that is, when the change in barometer causes the air to flow in the same direction as that due to change in temperature, the maximum change is larger and more penetrating than when the change is produced by only one of the causes or when they act in the opposite direction.

This sort of change is commercially unavoidable, and to make that statement more convincing assume that we have an insulating wall built perfectly air-tight and that

the barometric pressure decreases a little more than 2 in. of mercury. Then the air pressure in the wall will be in excess of that outside of the wall by 1 lb. per sq.in. or 144 lb. per sq.ft. of wall surface, a pressure which few insulating walls will stand. But suppose that in addition to this the temperature of the air in the wall increases 50 to 60 deg., thereby adding a pressure of 1½ lb. per sq.in., making a total excess of pressure, of 2½ lb. per sq.in., or 360 lb. per sq.ft. inside of the wall, a pressure that no ordinary wall construction would stand. This is the process by which the breathing ports are formed in insulation construction, and once they are formed, the breathing action goes on uninterrupted.

This action may be detrimental to the wall, or it may do no harm and may even be beneficial under certain conditions, depending upon the location of the breathing ports. If these are located so as to inhale warm air from the outside, that air may be cooled below its dew-point inside the wall and drop some moisture, and during exhalation it would go out colder and drier. This constitutes a wetting process, producing all of the ills that moisture is capable of producing in the wall. But if the breathing ports are so placed that air at a lower temperature than that inside the wall is inhaled, the fresh-air supply cannot be cooled below its dew-point and no moisture can be supplied by it to the contents unless they have the power of taking moisture from it at temperatures higher than its dew-point, which is unusual. Normally, this condition of breathing would constitute a drying process and in general may be considered beneficial rather than detrimental.

This breathing action is practically unavoidable and efforts should be directed to govern it instead of trying to avoid it.

Then, with these facts in mind, one condition of insulation construction becomes of importance, that is, that the outside shield over the insulating material should be continuous, strong, more or less flexible and impervious to air; breathing ports should be from the inside of the refrigerated chamber. It seems that it might even be advisable to provide artificial ports and passages to facilitate this breathing action to avoid breaking the outside shield. It is not uncommon to find walls in which the outside air has more or less free passage in places clear through to the inside plaster coat, to which moisture is brought, causing the plaster to deteriorate and drop away. Large isolated air pockets in the wall may also injure this plaster coat by change of pressure, as explained.

In tearing away old wall construction, it is common to find large patches of insulating material, and also the material of the retaining wall, moist and badly rotted, while most of the material in the wall seems as bright as the day it was put in. These spots are usually caused by the access of outside air to the wall, but they may also be caused by the access of moisture due to sweating on the inner surface of the wall, which should also be guarded against.

By a careful exercise of the precautions mentioned it is possible to preserve quite indefinitely the wall construction of any ordinary material. The precautions are much more important with the cheaper materials subject to rapid deterioration by moisture than with the more expensive kinds of insulation, but in many cases, especially where the service is to be of short duration, it may be advisable to use the cheaper materials.

JUST FOR FUN

Laugh if You Can, or Cuss

Some two months after a 1-in. return trap had been shipped, I received a note to the effect that the apparatus could not be made to do the desired work. A visit to the plant showed that this return trap had been set up in accordance with a cut of a separating trap that the engineer had somehow managed to get hold of, and as a matter of course it had never made a stroke.

I explained to the superintendent that a return trap cost $12 more than a separating trap, which should have been ordered and that "for the good of the trade" I would exchange, and refund the $12 if desired. I suggested that by taking the return trap from the fire-room floor where it had been set, placing it on top of the boiler and connecting it up properly, he could send all the returns directly back to the boiler and cut out the pump entirely, which in this case had proved costly to maintain.

This plan was followed and a more pleased man was not to be found in that section of the state. This is given as a confirmation of the old saw, "A little learning is a dangerous thing."—W. H. Odell, Yonkers, N. Y.

Assumed Wisdom Usually So

What unpleasant things can happen to a firm through technically unskilled clerks, who think they know just as much as the engineer in the shop or the draftsman in the office, is shown in the following case.

In a noted concern orders for the very speedy delivery of simple machine parts like pins, flanges and the like, exactly described in a letter, were sometimes (against the rule) handled directly by the commercial office. Once, an order for a simple belt pulley, with particulars plainly stated by the customer, was received. A clerk, seeing no necessity for notifying the chief draftsman, put some notes on an order blank, and signing himself as a responsible person, issued the order. A few days afterward a letter was received from the customer, complaining that besides making a little mistake on the rim, the keyway mentioned in the order had been forgotten.

The clerk, discovering his error and wishing to avoid censure, but not yet informed on the technical question, hurried to answer the letter somewhat like this: "We are awfully sorry to say that our shipping department made a little mistake, but we will send you that forgotten keyway by return mail."—B. E. Würzburg, Providence, R. I.

They Do Sometimes Escape

It was a good many years ago, but not so long that any of the participants have forgotten it. The night fireman had been told to take out the manhole plate and wash out the boiler. Being unable to remove the plate, he called on the watchman for help. Together, they pushed and kicked on it, but without success. There was ten pounds of steam on the boiler but of course that had nothing to do with it, the old plate must be stuck on. A large piece of timber was secured and used as a battering ram—and it opened the boiler! Their lives were saved, but the scalds they received were serious enough to insure that neither will every try that stunt again.—William E. Dixon, Cambridge, Mass.

Changes in an Old Plant

By Newton L. Schloss

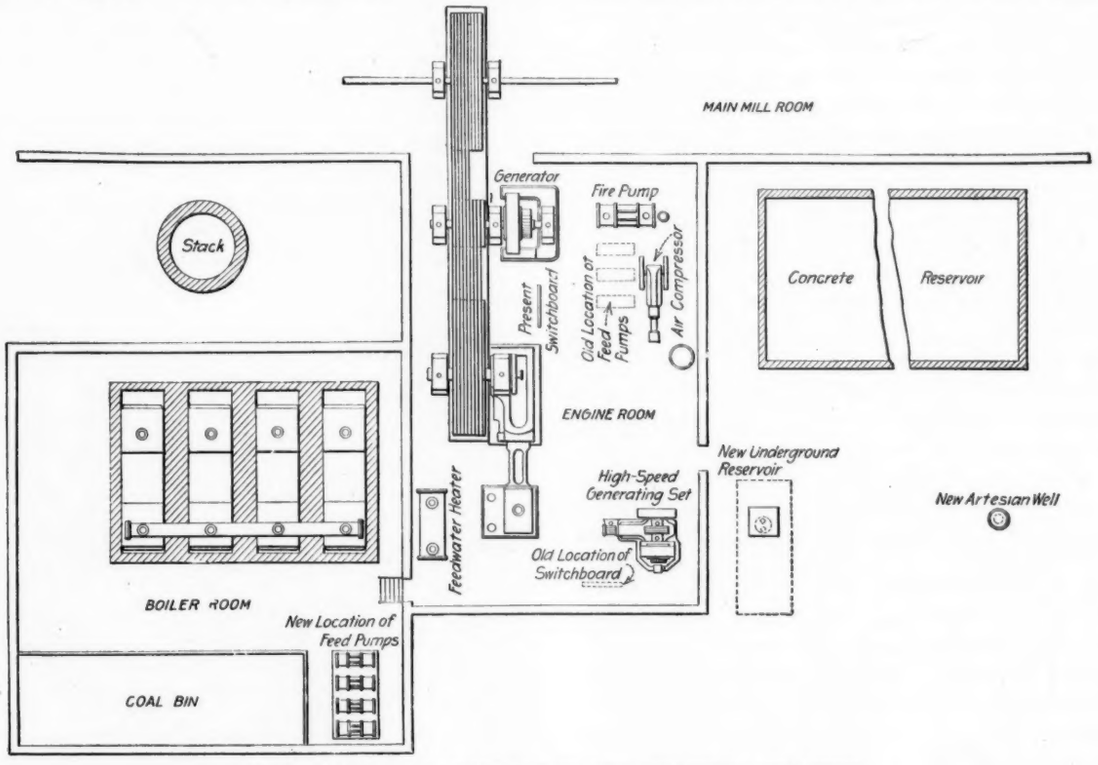
SYNOPSIS—The installation of a feedwater heater, the relocation of some of the apparatus, the covering of pipe, and the services of a new chief engineer convert a run-down plant into one producing excellent results. On reading the article you cannot but wonder how many more plants are in this one's former condition.

When the new management of a plant manufacturing rubber goods took over the manufacture and sale of the product, the writer was retained to inspect the mechanical and electrical equipment and report what immediate changes were necessary to bring the plant uptodate and at the same time provide sufficient capacity to operate the motors in another mill owned by the same interests, and yet keep the cost of such changes and additions down to a minimum.

This inspection revealed a condition that, no doubt, can be found in many plants, one of the most serious features being the lack of an efficient engineering staff.

The horizontal-tubular boilers, though originally well built, were (doubtless through neglect and abuse of long standing) in bad condition and were being poorly operated, as regards both safety and economy; such antiquities as hand-controlled dampers and stiff single-valve boiler connections being among the evidences of the lack of uptodate power-plant practice. The feed-water heater was of the closed type and had outlived its usefulness, and the boiler-feed pumps, which were being used for general supply as well as boiler feeding, were located, as shown by the sketch, in the engine room 120 ft. from the last boiler. No attention was paid to returning the drips to the boilers, and such a thing as a trap was almost unheard of.

Where covering had been applied to the high-pressure piping, it was in many cases of the cheap sort, improperly applied, and generally of insufficient thickness. Measuring instruments for recording the quantities of steam, water and electricity were not in use. A separator of a well and favorably known make had been removed from the Corliss-engine supply pipe and relegated to the scrap heap as not having any particular value. An old air-operated well was not getting sufficient air from a compressor located over 300 ft. away, and as a result large quantities of costly city water were being used for boiler and manufacturing purposes.



DIAGRAMMATIC LAYOUT OF PLANT, SHOWING CHANGES

The first recommendation made was for the selection of a competent chief engineer at a satisfactory salary, with power to discharge such of the original force as he deemed best and employ such new men as he found necessary to create an efficient engineering force.

Recommendations covered new boilers, boiler-feed pumps, open-type feed-water heater, a system of damper regulation or controlled combustion, an entire change in the high-pressure drips, the proper covering of steam, exhaust and drip piping, rearrangement of the boiler-feed pumps and feed-water heater connections, a new air compressor and an independent system of air supply, together with a properly driven and connected artesian well and connection to and from the compressor, well and reservoirs. The owners were not disposed to install new boilers at this time, but called in the boiler makers to thoroughly overhaul them. A new 1000-hp. combina-

tion open feed-water heater and grease extractor was installed and where there was difficulty in maintaining 150 deg. F. with the old heater, 210 deg. F. is maintained with the new one. The boiler-feed pumps were removed as shown to a new position in the boiler room, and the system of feed-water piping changed to conform to their new location and the new feed-water heater requirements.

The high-pressure steam and exhaust piping is being changed and properly valved. The system of drips recommended is being installed, with traps in service where required. Eighty-five per cent. magnesia covering is being applied to the steam, exhaust and drip lines. The old separator has been placed in service again in the Corliss-engine steam line with splendid results. A new air compressor has been installed, and the plant is beginning to have the general appearance of being thoroughly modern. While it is rather early to give accurate figures on the saving in coal, water, oil, labor, etc., the new chief engineer estimates that the saving in coal with almost twice the load is about three tons per day, and the saving in well water about 50,000 gal. per day. The use of city water for power-plant and manufacturing purposes has been discontinued, and figures from the accounting department show that the saving by this will be nearly $1500 per year. No estimate can be made at this time of the saving due to lowering the cost of maintenance and repairs, but it will be appreciable.

Perhaps the most interesting of the changes and additions made was the method finally determined upon to provide electric light and power for the other mill referred to. In addition to the horizontal-tubular boilers, the power plant had a 32x48-in. Corliss engine, 72 r.p.m., and 100 lb. initial steam pressure. This had a main sheave 18 ft. in diameter, grooved for 16 ropes and drove a sheave of the same diameter on the main shaft in the rubber-mill room. A 50-kw. high-speed engine direct-connected to a 115-volt, direct-current generator, was used for supplying light for the factory, power plant and offices and power for a few emergency motors. Tests showed that the Corliss engine was carrying a load of less than one-half its rated capacity, and the new management was advised that there was sufficient unused engine capacity to operate a 200-kw. generator.

At first it was suggested that a belted generator be driven from a new pulley to be mounted on the main mill shaft, but this method of transmission was found to be impractical for the reason that the main shaft was too small and the construction of the sheave and rope pits created structural conditions that would involve too large an expenditure of money for excavation, mason work and structural steel. After much study of space and rope center conditions it was decided to set the generator in a position that would enable it to be driven by six of the original 16 ropes. The illustration shows how this has been accomplished. To bring about this result, we were fortunate enough to secure a second-hand generator wound for 125 volts, 200 kw., at 216 r.p.m., that was in good condition. This generator was of the direct-connected engine type and was equipped with the usual outboard bearing and a short flanged shaft. It was therefore necessary to have a new shaft, and to secure two new pedestal bearings and a sheave for the six ropes and three-to-one speed conditions. It was comparatively easy to get the bearings and new shaft, but difficult to obtain a new sheave, without serious delay, to properly fit the conditions. It will be noted that the pedestal bearings are located on each side of the rope pit and the height from the floor level is such that there is ample room between the engine sheave ropes and extended generator shaft for free movement of the main driving ropes.

To further simplify the construction, reduce first cost and insure economy, it was decided to combine the generator panels of the old and the new units and place them alongside of the new 200-kw. unit, about as shown. The whole change has resulted in an appreciable saving.

The system of water supply for both boiler and manufacturing purposes is also interesting, and is arranged as follows: The 67,000-gal. reservoir receives part of the artesian-well discharge, the balance of which will be discharged to the roof tank on the new building now in course of construction, and will be used for drinking purposes. From this reservoir the mill pump takes its suction and then discharges this cold-water supply to the various mills and calenders. Passing through these machines the water takes up considerable heat and, as it leaves the machines, flows by gravity to the new 7½x18-ft. underground steel tank, which serves as a water supply for the new feed-water heater and boilers. The reservoir also serves as a source of supply for the fire pumps and fire-service system.

The boiler-feed, heater and mill pumps as relocated in the boiler room have their suction and discharge connections piped into manifold headers, thus making them interchangeable for any service required of them.

Seamless Drawn Steel Tubes

Three principal classes of material used in the manufacture of seamless openhearth steel tubes by the National Tube Co. are 0.17 per cent. carbon, 0.35 per cent. carbon and 3½ per cent. nickel. The physical and chemical properties of the 0.17 per cent. carbon steel are:

Chemical Analysis:

Carbon	0.14 to 0.19 per cent.
Manganese	0.40 to 0.60 per cent.
Sulphur	0.015 to 0.040 per cent.
Phosphorus	0.010 to 0.035 per cent.

Temper S. Physical Properties (unannealed):

Elastic limit	60,000 to 70,000 lb. per sq.in.
Ultimate strength	65,000 to 80,000 lb. per sq.in.
Elongation in 2 in.	12 to 18 per cent.
Elongation in 8 in.	3 to 7 per cent.
Reduction of area	20 to 30 per cent.

Material of this temper is of maximum strength, but with slight ductility, and is used for purposes other than conveying fluids.

BOILER TUBES, STEEL

Temper W. Soft and Anneal:

Elastic limit	27,000 to 35,000 lb. per sq.in.
Ultimate strength	47,000 to 55,000 lb. per sq.in.
Elongation in 2 in.	55 to 65 per cent.
Elongation in 8 in.	28 to 33 per cent.
Reduction of area	52 to 62 per cent.

Material of this temper is suitable for boiler tubes for all purposes. It is soft and ductile and will stand considerable cold forming.

PIPE STEEL

The steel from which the pipe is made must show the following physical properties:

Tensile strength	52,000 to 62,000 lb. per sq.in.
Elastic limit	Not less than 30,000 lb. per sq.in.
Elongation in 8 in.	Not less than 20 per cent.
Reduction in area	Not less than 50 per cent.

A test piece cut lengthwise from the pipe and filed smooth on the edge should bend through 180 deg. with an inner diameter at the bend equal to the thickness of the material, without fracture.

Internal pressure test applied to the respective sizes of standard butt and lap-weld pipe is as indicated in table:

Nominal Size	Method of Manufacture	Test Pressure, Lb.
⅛ in. to 2 in. (inclusive)	Butt weld	700
2½ in. and 3 in.	Butt weld	800
Up to 8 in.	Lap weld	1000
9 and 10 in.	Lap weld	900
11 and 12 in.	Lap weld	800
13 and 14 in.	Lap weld	700
15 in.	Lap weld	600

Improved Rolling Hatchet Planimeter

By Frederick W. Salmon

The usual way of making and using a hatchet planimeter consisting of a bent wire with a sharp marking edge that will track well after the tracing point, is illustrated in Fig. 1. With the tracing point on the center of gravity *A* of the figure to be measured, pass directly to some point, as *B*, on the boundary line of the figure, then trace the figure from *B* to *CDEFG* and back to *B*, thence to *A*. The distance between the points where the marking edge starts and ends (a and a_2), or the departure, multiplied by the length of the hatchet planimeter in the same units (inches), will give the area of the figure in the same units (square inches).

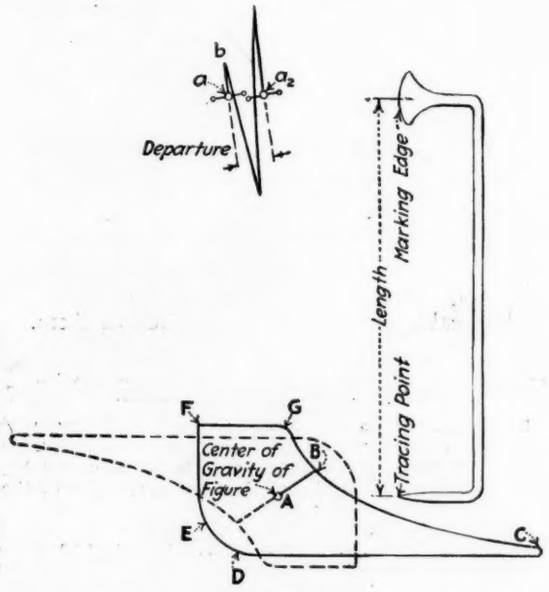


FIG. 1. HATCHET PLANIMETER

In many cases the location of the center of gravity can be judged sufficiently closely, or if desired, the figure may be revolved about the assumed center of gravity and the planimeter run over it a second time, starting from *A* in both cases, and taking the mean "departure." Of course, if we revolve the figure it should be turned through 180 degrees, as shown by the dotted lines. This method is less laborious than the methods given in textbooks on geometry.

In actual practice several difficulties creep in when using a planimeter made in this way. First, the departure is generally a very small amount and hard to read very accurately. This may be avoided to some extent by running over the figure several times; the writer likes to take five trips with the figure in each position, so as to get a good average. Second, the marking edge gives but a very faint line. Third, it is difficult to handle the tracing point so as not to exert some twisting tendency, which, of course, leads to errors in the line produced by the marking edge. Fourth, it is difficult to keep the marking edge perpendicular to the paper, and it naturally has a tendency to ride toward the side to which it leans, owing to its rounded shape. Fifth, if the marking edge is well rounded as shown it will track well, but it will be difficult to choose the exact points between which to take the departure measurements, and if the marking edge is much less rounded it will not track so well and may have very erratic action.

These difficulties are largely overcome in the improved style of planimeter shown, by passing it over the figure to be measured several times, preferably five, reversing the figure and passing over it five more times and taking the mean departure. The greater weight of the instrument shown in Fig. 2 overcomes to a large extent the second trouble, while the third will not amount to much with a heavy instrument if it is handled in a delicate manner. The first and second radius bars, made of wire about ⅛-in. diameter, free at all the joints but not shaky, entirely do away with the fourth difficulty. The fifth is disposed of by the use of the pricker point *D*, which is simply the pointed end of a piece of wire about $\frac{1}{16}$-in. diameter, bent as indicated, and secured in a notch cut in the beam so that the point will be as near as possible in line with the axis of the marking wheel. The weight of this wire is carried by the rubber band *E* when not in use. With the tracing point at *A* as before and the marking wheel at *a*, press down the pricking point and mark the paper. Then, after passing the tracing point around the figure press it down again and draw light lines from mark to mark across the line made by the marking wheel, and the exact points a and a_2 will be established between which to carefully measure the departure, as shown in Fig. 1. The departure multiplied by the length gives the area of the figure, as before stated.

Supporting point *H* should be very smooth and just long enough to ride lightly on the paper, and there should be about a four-ounce weight on the end of the beam over the marking wheel *A* to cause it to give a clear mark on the paper, and about a two-ounce weight balanced neatly on the ring head of the anchor pin of radius bar *G*, to make sure that it stays where put on the paper.

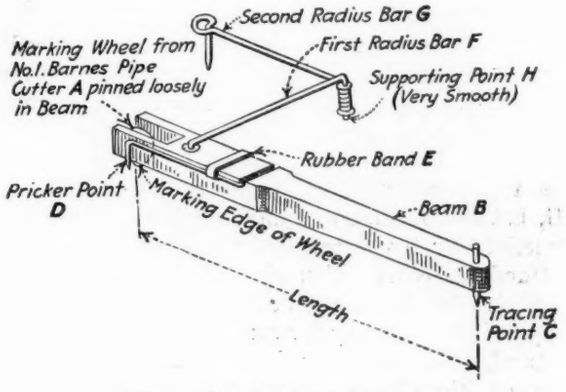

Second Radius Bar G
First Radius Bar F
Marking Wheel from No.1 Barnes Pipe Cutter A pinned loosely in Beam
Supporting Point H (Very Smooth)
Rubber Band E
Pricker Point D
Marking Edge of Wheel
Beam B
Length
Tracing Point C

FIG. 2. ROLLING PLANIMETER

The cost of such a planimeter is practically nothing, and it can be put together with a pocket knife and a pair of pliers. In making the first radius bar I have found that little copper rivet washers soldered on are very convenient. The second radius bar is simply twisted closely round the first at *H* to form a hinge, and care should be taken that it does not bind in any position. A wire nail neatly filed to a point makes a good tracing point. The planimeter may be used for measuring not only indicator diagrams, but land surveys, sections of boats, etc., and can be made of different sizes up to several feet long, using the same marking wheel.

Portable Pipe-Reaming Machine

The portable pipe-reaming machine shown in the accompanying illustrations is designed for use on pipes larger than ¾ in. diameter. It weighs 25 lb. and reams nine sizes of pipe—¾-in. to 4-in., inclusive. It is constructed of malleable iron and steel castings, with cutting reamers of high-carbon steel. The jaws will take in a 4-in. coupling, making it possible by using the coupling as a nipple holder to ream a 4-in. nipple.

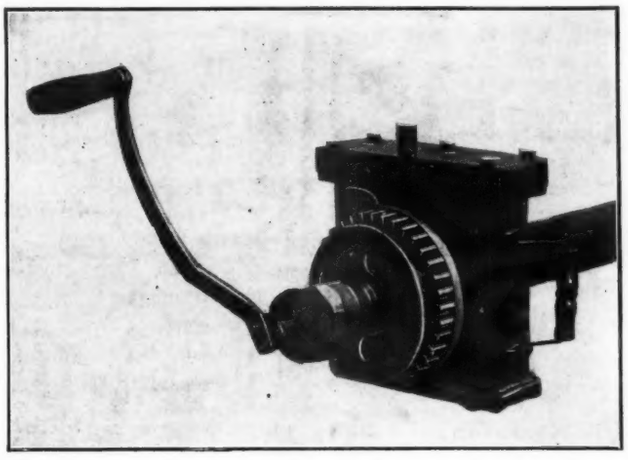


FIG. 1. PORTABLE PIPE-REAMING MACHINE WITH PIPE IN THE CHUCK

The machine is attached to a pipe by means of self-centering chuck jaws. These are designed with the advantages of a universal chuck.

The cutting reamer has a shaft which slides on two keys, or feathers, through the hub of the main gear and is carried forward into the pipe by means of a hand feed-nut similar to that on a drill ratchet. Thus the cutting reamer, when in operation, has both a rotating and a longitudinal motion. The main gear is actuated by a drive pinion, which is turned by a handcrank. Three revolutions of the handcrank make one revolution of the main gear.

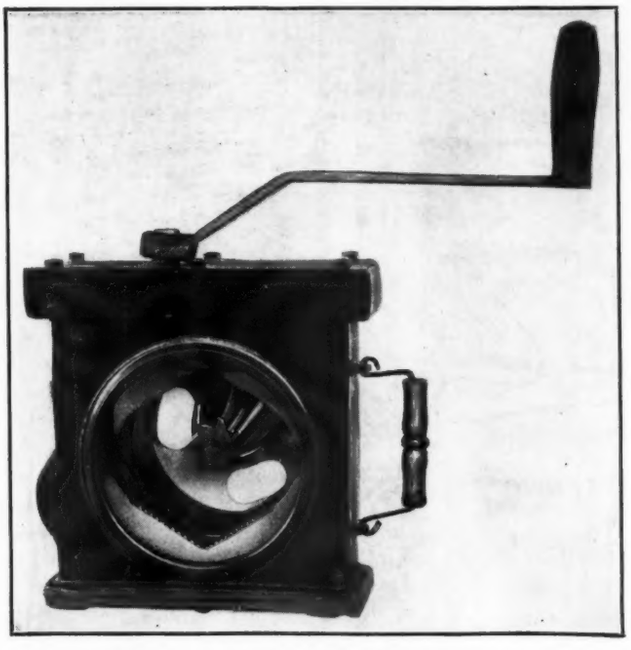


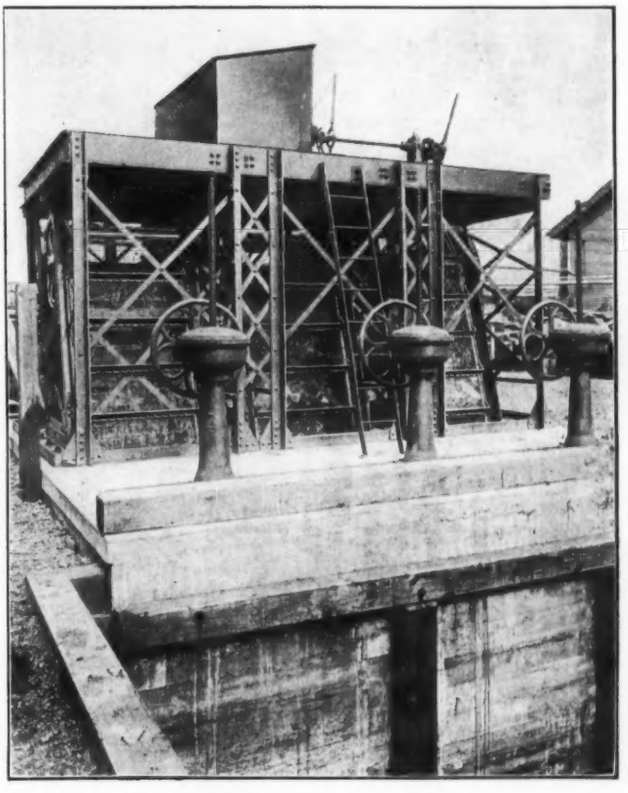
FIG. 2. SHOWING CUTTING REAMER

This machine is manufactured by Henry Hillegass, Houghton, Mich.

Traveling Water Screens

By Henry J. Edsall

In order to keep out fish and miscellaneous trash from condenser intake pipes, it has been the custom to protect the entrance to the pipes with fixed screens. The flow of the water carries a certain amount of trash against a fixed screen and it soon becomes clogged, especially if it is of a fine enough mesh to be really effective. To overcome this trouble and avoid the reduction in the amount of condenser water and the trouble and expense of keeping the screen cleaned off, it is becoming standard practice to use traveling screens carried along slowly by two strands of chain running over sprocket wheels at the head and foot, small ledges being attached to the screens to serve as buckets to pick up the trash, carry it over the head and discharge it into a fixed trough or some other receptacle. At the point where the screens turn and start to descend, a water spray can be arranged to come from the inside of the screen and wash the trash from the outside into the receptacle. This makes an automatic self-cleaning type of screen and avoids delays and expense.



TRAVELING SCREEN WITH SILENT-CHAIN SPEED-REDUCING GEAR

The equipment shown in the illustration was installed in 1914 at the plant of the Beacon Light Co., Chester, Penn., this company being a subsidiary of the Philadelphia Electric Co. The frames are made up of small angle irons welded together at the corners, and the screens are made of No. 14 B. & S. gage copper wire with

½-in. mesh holes. Bronze bolts are used for securing the screens to the frames. The chains that carry the screen frames are 18-in. pitch steel straps with ⅜x2½-in. links, ¾-in. pins, bronze bushings and 4½-in. cast-iron rollers. They run over 41½-in. sprocket wheels at the head and foot, the foot shaft being fixed and the head shaft arranged with a takeup for the stretch in the chain. The head and foot shafts are about 24-ft. centers and the travel of the chains is about 12 ft. per min. This means only about one revolution per minute for the head shaft, and in order to obtain this slow speed a silent-chain speed-reducing gear was used to reduce from the 555 revolutions of the motor to 4.86 revolutions for the countershaft in one reduction. The drive from the countershaft to the three head shafts is accomplished by means of chain drives set at such an angle that the taking up of slack with the take-up arrangement will not appreciably affect the drives.

The screen frames are each 3 ft. 10⅝ in. long by 17⅝ in. wide. Each apron therefore presents a screening surface nearly 4 ft. wide and, as there are three units, the total screening surface with all three machines in operation would be nearly 12 ft. in width. The depth of the screen under water would vary somewhat with the variation in water level, but would probably be from 8 to 12 ft. under all ordinary conditions, or slightly more for unusually great differences in water level.

The effective screening surface is reduced somewhat by the area taken up by the angle-iron frames that carry the screens. The capacity of the condenser pump is between 8000 and 9000 gal. per min. The Philadelphia Electric Co. is now getting ready to install similar screens at the large power house at Twenty-sixth and Christian Streets.

A Famous Cornish Pump

Twenty-five years ago the Oliver Iron Mining Co., of Iron Mountain, Mich., installed one of the largest pumping engines in the United States, Fig. 1. Its immense size and a rated lift of 2000 ft. make the pump of interest. It is of the Cornish type and was made by the E. P. Allis Co., of Milwaukee. Originally the pump was installed at the "D" Chapin shaft and pumped from a depth of approximately 600 ft. Soon after its installation, however, the shaft began to get out of alignment, and it was necessary to abandon the shaft and dismantle the pump. Seven years ago this pump was reinstalled at the "C" Ludington shaft to pump from a depth of 1513 feet.

The engine is a 50&100x120-in. steeple-compound condensing machine, and on its main shaft is mounted a flywheel 40 ft. in diameter and weighing 160 tons. The height of the engine from the top of the foundation to the top of the high-pressure cylinder is 54 ft. This engine operates, through a walking-beam, a series of eight 28x120-in. stroke, single-acting plunger pumps, located in the shaft at intervals of about 200 ft., Fig. 2.

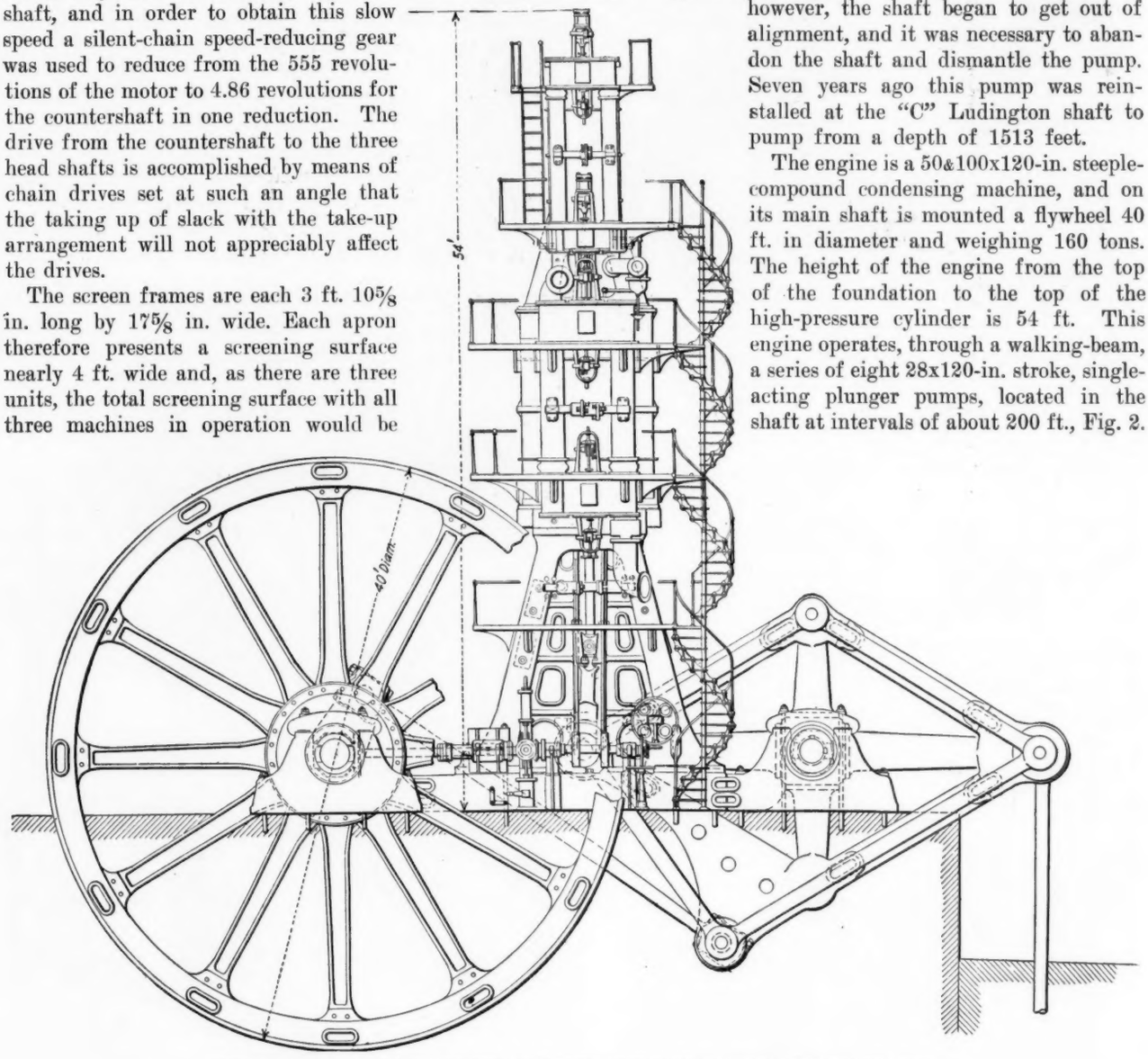


FIG. 1. ONE OF THE LARGEST PUMPING ENGINES IN THE UNITED STATES

The pump rod is solid openhearth steel, 8 in. in diameter for the top 800 ft. and 7 in. for the lower 700 ft. The plungers are 28 in. in diameter, and the displacement is practically 295 gal. per rev. The total weight of the engine is 600 tons; the total weight of the moving parts in the shaft is 325 tons.

During a 12-month period this pump operated 99.5 per cent. of the entire time at a rate of 6.63 r.p.m., pumping 1922 gal. per min. against a head of 1513 ft. The average delivered horsepower was 736, and the average indicated horsepower, 831, making the mechanical efficiency 88.6 per cent. The duty performed was 86,200,000 ft.-lb. of

work per 1000 lb. of steam, including all auxiliaries. The lift is divided up into eight relays. A suction tank near each pump receives the discharge from the pump below,

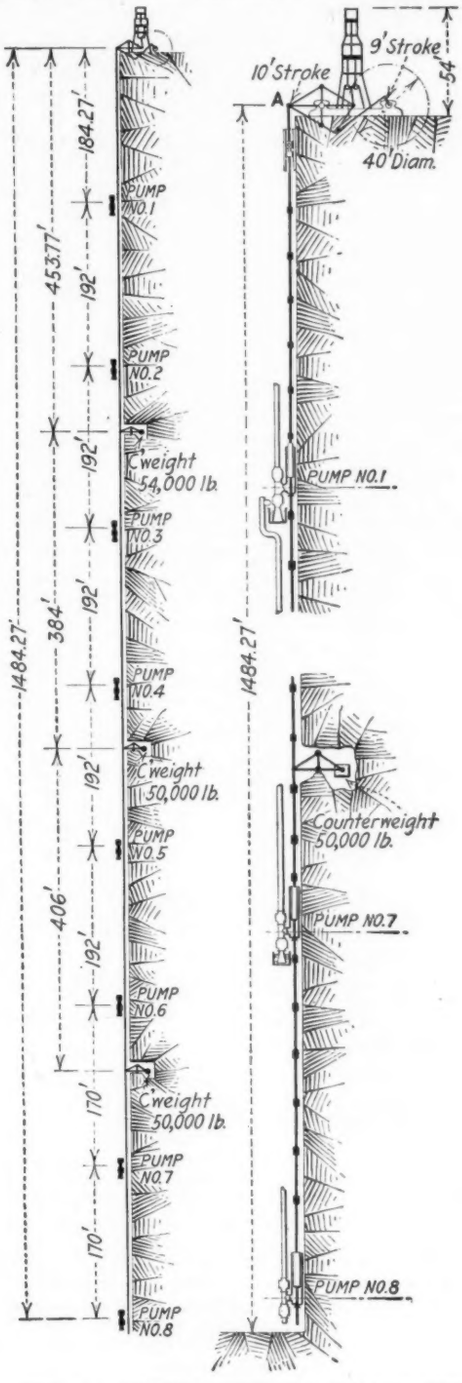


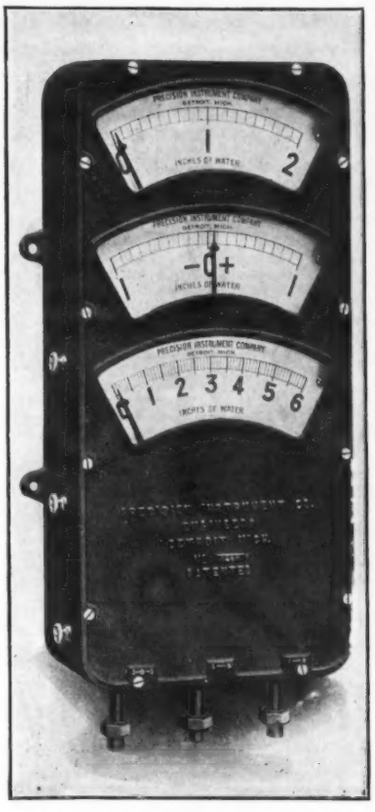
FIG. 2. CORNISH PUMP AT CHAPIN MINE

as shown in Fig. 2. Counterweights at 400-ft. intervals remove much of the weight of the shaft from the crosshead at the top.

A Cement for Wet Places, like aquariums, is made of litharge, fine white sand and plaster of paris (calcined plaster), each one part, and resin one-third part. These ingredients should be thoroughly mixed and made into a paste with boiled linseed oil to which a drier has been added. It should then be thoroughly mixed by heating and allowed to stand four or five hours before using. It should not stand much longer than this, as the cement becomes worthless after it has been mixed twelve or fifteen hours. Glass may be cemented to wood or metal with this preparation, and it will resist the action of both fresh and salt water.

Precision Triple-Dial Gage

A compact triple-dial gage for use in air or gas systems where an indication of pressures or vacuums at various points is desired has recently been perfected by the Precision Instrument Co., of Detroit. An exterior view of the gage is shown in the accompanying illustration. It can be furnished in any range to 10 lb. pressure or vacuum. The working parts are of the usual "dead-beat" type designed by this company. Variations in pressure or vacuum are transmitted by a diaphragm through a vertical adjustable plunger which is attached to a horizontal shaft by means of a lever adjustable in length. This shaft is supported by a bracket and is normal to the plane of the chart disk. It converts the reciprocating motion of the diaphragm to rotary motion. The pen arm is suspended from the shaft and at right angles with it, so that when the shaft revolves the pen arm moves parallel to the chart, keeping the pen in contact with it. The shaft is suspended in point bearings. The low-pressure gages are exceedingly sensitive and are equipped with damping cocks. In the present design the three dials and the corresponding mechanism for each are mounted in close proximity in a single case. As a consequence they occupy less space than where three independent gages are used and make comparative readings simple.



EXTERIOR OF GAGE

Office-Building Service Data

By W. R. Metz

It is not often that we can find any accurate data regarding the amount of steam required for heating large buildings or current required for light and power, and this is written in the hope that it will be found useful to some of the engineers who read this paper.

About a year ago a new building was erected close to the one of which I have charge and it was decided, for several reasons, to enlarge our plant sufficiently to heat and light the new building. The data given for the purpose were as follows:

Total square feet floor area	327,000
Cubic contents (feet)	5,860,000
Square feet direct radiation	27,000
Square feet in cooling coils	2,500
Square feet in fan blast coils	11,000
Cubic feet in building per square foot of radiation	98
Total horsepower of all electric motors	710

Reducing the area in the fan-blast coils to the equivalent direct radiation gives 33,000, and adding the square feet of direct radiation gives a total of about 62,500 sq.ft. of direct radiation.

According to accepted rules for heating, we would then have per season of 220 days

$$62{,}500 \times 500 = 31{,}250{,}000 \textit{ lb. steam,}$$

or an average demand of

$$\frac{31{,}250{,}000}{24 \times 220} = \textit{approx. } 6000 \textit{ lb.}$$

of steam per hour. The maximum demand at 0 degree F. would be about 15,000 lb. per hour.

In estimating for the total kw.-hr. per year for light and power we have

327,000 *sq.ft. floor area* × 2 = 654,000 *kw.-hr.*, or

$$\frac{654{,}000}{12} = 54{,}000 \textit{ kw.-hr. per month}$$

The maximum demand would be

$$\frac{654{,}000}{8{,}760} \times 2 = 150 \textit{ kw.}, \text{ or}$$

$$150 \textit{ kw.} = 150{,}000 \div 220 = 700 \textit{ amperes.}$$

The total distance from our power plant to the new building is about 1000 ft. and for steam we installed a 6-in. and a 2-in. pipe, the former for winter and the latter for summer use. For the electric-power service we have two circuits consisting of two 1,500,000-cm. cables each and for the lighting one three-wire circuit, the two outside legs being 1,500,000-cm. and the neutral 750,000-cm. cable.

Steam is introduced at 50 lb. pressure at our building and the loss in pressure is from 4 to 5 lb., giving about 45 lb. at the new building. This comparatively high pressure is maintained on account of the operation of pumps, laundry machinery and the like. The heating is done with a vacuum system.

The following readings, taken from a General Electric steam-flow meter, during the month of December, 1914, will show how actual results compared with the estimates.

Date, Dec., 1914	Total Steam Used, Lb.	Highest Rate per Hr.	Lowest Rate per Hr.	Av. Rate per Hr.	Temperature High	Temperature Low	Temperature Mean	Av. Steam per Cu. Ft. of Bldg. per Hr.	Av. Steam per Sq. Ft. Rad. per Hr.	Cost per Hr. @ 33c. per 1000 Lb.
1	127,536	5,314	5314	5314	60	52	56	0.00090	0.088	$1.75
2	150,323	6,907	5314	6111	64	47	56	0.00104	0.102	2.01
3	158,888	7,971	5314	6642	64	50	57	0.00113	0.110	2.19
4	165,531	8,502	6376	6907	52	42	47	0.00118	0.115	2.28
5	198,478	9,299	6907	7971	44	35	40	0.00135	0.133	2.63
6	191,835	8,768	7438	7971	37	34	36	0.00135	0.133	2.63
7	182,270	9,829	6642	7438	37	34	36	0.00127	0.124	2.45
8	162,173	8,502	6642	7173	42	35	38	0.00122	0.119	2.34
9	159,420	6,642	6642	6642	39	36	38	0.00113	0.110	2.19
10	149,855	7,438	6642	6907	37	33	35	0.00118	0.115	2.28
11	177,222	7,971	6907	7438	36	34	35	0.00127	0.124	2.45
12	172,173	7,971	6642	7173	36	28	32	0.00122	0.119	2.34
13	157,560	6,907	6376	6642	37	28	32	0.00112	0.110	2.19
14	189,444	8,768	7438	7704	38	16	27	0.00132	0.128	2.54
15	236,473	10,894	8502	9829	20	11	16	0.00167	0.164	3.24
16	212,568	11,159	7971	8768	27	11	19	0.00150	0.146	2.84
17	159,420	7,971	5314	6642	28	14	21	0.00113	0.110	2.19
18	172,705	8,502	5845	7173	36	13	24	0.00122	0.119	2.34
19	159,420	6,907	6376	6642	38	28	33	0.00113	0.110	2.19
20	175,362	7,971	6642	7173	41	32	36	0.00122	0.119	2.34
21	170,579	7,971	6642	6907	43	30	36	0.00118	0.115	2.28
22	185,990	8,768	7173	7971	38	28	33	0.00135	0.133	2.63
23	188,647	8,502	7173	7704	38	19	28	0.00132	0.128	2.54
24	159,420	7,173	6376	6642	29	25	27	0.00113	0.110	2.19
25	199,275	9,564	7173	8236	34	16	25	0.00141	0.137	2.72
26	213,888	10,095	7971	8768	18	6	12	0.00150	0.146	2.89
27	213,888	10,095	7971	8768	28	2	15	0.00150	0.146	2.89
28	168,391	8,236	5845	6907	36	10	23	0.00118	0.115	2.28
29	163,405	8,502	6111	6642	34	30	32	0.00113	0.110	2.19
30	162,077	7,971	5845	6907	45	32	38	0.00118	0.115	2.28
31	162,874	8,502	5314	6907	34	29	32	0.00118	0.115	2.28
Av. Total	5,447,090	8,373	6285	7536	38.4	27.1	32.8	0.00128	0.122	$2.49

Cost of steam per month	$1,797.54	
Cost of steam per cu.ft. of building (per month)		0.000306
Cost of steam per sq.ft. floor area (per month)		0.0055
Cost of steam per sq.ft. radiation (per month)		0.02995

The total electric current for light and power for the month was 78,000 kw.-hr., of which 61,500 was for light and 16,500 for power. The maximum demand was 800 amperes at 220 volts.

The following tables give the daily consumption of current for the month, the number and size of lamps installed and other pertinent data.

DAILY CONSUMPTION OF ELECTRIC CURRENT

Date, Dec., 1914	Light, Kw.-hr. Circuit No. 1	Power of Motors, Kw.-hr. Circuit No. 2	Circuit No. 2	Total
1	1,900	300	300	2,500
2	1,900	300	300	2,500
3	2,000	200	400	2,600
4	1,900	300	300	2,500
5	2,000	300	300	2,600
6	1,800	000	100	1,900
7	2,200	300	300	2,800
8	2,100	300	300	2,700
9	2,200	200	300	2,700
10	2,300	300	300	2,900
11	2,300	200	300	2,800
12	2,000	200	300	2,500
13	1,800	100	100	2,000
14	2,300	300	300	2,900
15	1,900	300	200	2,400
16	1,900	300	300	2,500
17	1,900	200	400	2,500
18	1,900	300	300	2,500
19	2,000	300	300	2,600
20	1,800	100	200	2,100
21	2,200	300	400	2,900
22	2,000	300	300	2,600
23	2,000	400	500	2,900
24	2,100	300	300	2,700
25	1,700	100	100	1,900
26	1,900	200	300	2,400
27	1,700	200	200	2,100
28	1,900	200	300	2,400
29	2,100	300	300	2,700
30	1,900	300	300	2,500
31	1,900	200	300	2,400
Total.....	61,500	7600	8900	78,000 kw.-hr. used

NO. AND SIZE OF LAMPS IN BUILDING (ALL TUNGSTEN LAMPS)

Wattage	500	250	100	60	40	25
Number installed	23	76	908	983	830	376

Total wattage of lamps installed	222,880 = 222.8 kw.
Wattage per sq.ft. floor area	0.68
Average wattage of lamps burning	82,666
Maximum wattage of lamps burning	129,600

It will be noted that while the figures for steam and electric current run in excess of the average as estimated, still both are about in accordance with the estimates so far as maximum demand is concerned, and it is probable that the average for the year will be fairly close to the estimated figures.

Plant Efficiency

The plant efficiency in which the average plant operator is most vitally interested is not so much a question of the last word in efficient apparatus which has been produced, as it is getting the best performance from the apparatus he has in his plant.

The plant, however lacking in design, however badly proportioned in the relation of the various units to each other, however badly adapted to the work it is required to do, represents an investment which must be taken into account when plant betterment is to be considered with a view to obtaining more economical operation and consequent efficiency. The condition confronting every plant owner is that he has a plant and from this plant he must get the largest output possible at the lowest operating expense. If he is unable to produce at a sufficiently low cost to compete, then he must make improvements which will increase the efficiency of this plant Each plant owner is, or should be, at all times striving to work his plant under the highest obtainable efficiency, which is only attained by keeping a close record of costs of operation.

To keep in touch with the operation of the plant to determine if it is working at the highest efficiency, it is necessary that a complete log be kept of all departments. This log of itself has no value unless it is carefully analyzed from day to day to determine whether the plant did maintain the highest efficiency on each particular day under the conditions at which it was necessary to operate.

The conditions of operation have as much bearing on the economy of the plant as does the operation of each piece of apparatus.—R. H. Tait, "Ice and Refrigeration."

Editorials

Digest of Boiler Laws

In view of the agitation for legislation affecting the construction and inspection of boilers, *Power* has digested the laws of all states having such laws and presents the digest with this issue. The reader will observe that the items of information are arranged in column form to facilitate reading and reference. The completeness of the classification is evident from the numerous column headings. It is the only digest of its kind ever published; and its value to all interested and affected by boiler legislation is obvious.

Broadening Responsibilities of the Engineer

An engineer in charge of the mechanical and electrical equipment of a great industrial plant recently remarked that the title "superintendent of motive power" more accurately expressed the responsibilities of his work than "chief engineer." There is truth in this which gives one a larger conception of the engineer's calling than many people hold. While local organizations vary widely, unquestionably the day is passing when ability to run an engine and pack a valve measures the fitness of a man to handle a complicated installation professionally, and it is in the development of the real professional viewpoint that the engineer prepares himself for broader usefulness.

In some plants the head of the operating staff reports to a mechanical superintendent, and there is a sharp distinction between the duties and executive authority of the two men; but in others the work is concentrated upon an individual who combines both administrative and advisory functions, and the longer title is therefore the fitter. In the case of the engineer who was discussing this matter, the entire electrical and mechanical service of a group of textile buildings is under his personal direction; and this includes the operation of the boiler plant, supervision of motor drives, the maintenance of hot-water heating, steam- and air-supply systems, the upkeep of elevators, oversight of the repair shop, study of safety conditions, and many other duties needless to catalog. Beyond this, he consults with the mill agent and superintendent of production in regard to the economic problems of the power installation and its allied departments, including the purchase of fuel, discussion of changes in equipment, costs and future policies.

Many chief engineers perform these duties, and in a sense their designation is of incidental importance only, nevertheless, many subordinate officials in modern industry have failed to realize the prestige which is their due, simply because their functions have not been accurately set forth in the "set-up" of their establishments. Sometimes within the organization itself, also, the absence of an official designation of sufficient comprehensiveness works to the disadvantage of the man who is carrying the responsibilities of a larger job than is indicated in his title. It is good policy to accurately express the scope of the engineer's duties in the label under which he works, and anything which helps his employers, his associates and the public to better appraise his usefulness and standing as a member of the staff of the organization helps to put engineering services on their proper plane of recognition and so ultimately to realize their just reward.

Definition of Load Factor

One of the most valuable activities of the national engineering societies is the standardization of terms, measures and expressions pertaining to engineering and power-house operations, for without a clear and general understanding of all terms, etc., any comprehensive comparison of power-plant operations, for instance, is well-nigh impossible. If one plant can secure certain results, it is desirable that the management of another plant should be able to make comparison with its results in the same line, but in order to do so accurately, the terms employed in each case should convey the same meaning. Most technical and shop terms are pretty generally understood, it is true, but there are still certain expressions that appear to mean one thing to some and something quite different to others; for instance, the term "load factor."

The national engineering societies have defined "load factor" as the ratio of the average load carried by a machine, plant or system within a given period of time to the maximum load carried within that period; yet a very common understanding of the same term is the ratio between the average load carried to the rated capacity of the machine, plant or system. Quite obviously, these two definitions are not the same and any such double meaning leads to confusion, for it is not always expedient to prefix the use of a term with a definition of what is actually meant. It is not practical, and the busy man demands concise and accurate statements that require no examination to make their meaning clear.

The societies' definition of load factor deals exclusively with questions pertaining to load—no other condition or consideration enters into the comparison. The other understanding of the term brings in the very unreliable factor of capacity. In these days when it is not at all uncommon to operate equipment at much over its rated capacity, it would be quite possible to conceive of an engine or other equipment being operated with a so-called "load factor" considerably greater than one hundred per cent.; that is, if the ratio of the average load to the rated capacity be understood.

The ratio of the average load to the rated capacity of a machine, plant or system is valuable information, however, and has been recognized by the engineering societies; being defined as the "plant factor." Though this term has not yet become as familiar to the operating engineer as that of load factor, there is certainly room for both terms, if they are not confused or used indiscriminately.

Looking Below the Surface

Nothing more clearly distinguishes an experienced engineer from a man of untrained judgment than ability to look below the surface in meeting the problems of his daily work. Hasty and superficial judgments are seldom rendered by one who appreciates the importance of considering uncertain factors in equipment matters. In trouble hunting rapid surveys of affairs are imperative, but practice enables an engineer to run over the possibilities of a situation at a speed which seems incredible to an outsider who does not realize the meaning of abnormal sounds in plant operation or the significance of slight changes in thermometer or gage readings in relation to the economical service of apparatus. Skill in diagnosing the causes of operating difficulties is by no means reaching snap decisions based on external appearances, and as the capacity and value of generating and auxiliary equipment increase, the importance of correctly "sizing up" such situations becomes very great.

In almost every department of power-plant service more than a superficial examination may at times be necessary to determine the reason for abnormal operating results. In the operation of the coal-handling system, a motor burnout may be due to a blockade of the bucket chain, to excessive bearing friction, or to some other cause; inefficient combustion may be the result of leaks in the flues, poor regulation of the draft, the use of unsuitable coal, etc.; and on the electrical side, sluggish operation of oil switches, control-wiring troubles and many other difficulties may occur from causes more or less obscure, which require some investigation to locate. Nothing the young engineer can do will help him more than thoroughly studying all equipment troubles that come within his observation, and discussing them with older men. Perhaps the most valuable features of conventions are the discussions of where different types of apparatus gave trouble in service, the remedies undertaken, and the lessons of avoidance for future operation.

Under the pressure of restoring service, the engineer may be tempted to guess at causes for certain difficulties, but it is better to hurt the service record for continuous running than to risk damaging the equipment by jumping at conclusions. No one expects a doctor to begin to operate on a patient until he has taken time to examine him, and the same opportunity must be given the engineer to look below the surface when action must be taken in emergencies. All reasonable precaution should be taken to limit the effects of local troubles, but once trouble occurs, it is rash not to take time to exercise trained judgment as to what is the real cause. The engineer who refuses to get "rattled" at such times and who cooly but swiftly makes his inspection is to be commended.

⁂

Unsymmetrical Operating Organizations

The engineer need not be discouraged when the efficiency expert plots an organization diagram of his station and unfolds an irregular and apparently unbalanced layout that seems to violate all the canons of scientific management. A power plant with a beautifully proportioned "family tree," which is pleasing to look upon, may be a model of good service, but that proves nothing with respect to the management of a station composed of mixed or heterogeneous apparatus. Whether the installation is properly organized or not depends upon the analysis of its individual conditions of design, administration and operation.

It is rarely feasible to run a station that is an outgrowth from early days of power production and that illustrates in its makeup a distinct evolution in equipment, with the evenly balanced staff one expects to find in a new plant built on the station-unit plan, with just so many boiler batteries for each engine or turbine set and extension possibilities to correspond. If an engineer knows that his men are all working to the best advantage in the face of the physical limitations, space requirements and machinery assembly, he need not worry about the lessons of the organization chart. It may help him to a better understanding of his installation's limitations, but if he knows just how each man on the staff is making good, he can afford to let the efficiency expert do the worrying.

One other side of station service may be mentioned in this connection. That is the very definite bent some men develop for certain kinds of work. Thus, in one group of hydro-electric plants in public-utility work one man has become an expert on governors. He devotes a large part of his time to the inspection, adjustment, maintenance and repair of this important part, and as a result the regulation on the system is superb. Probably an efficiency study of this system would recommend subdividing this work among several men, and certainly it would call for the training of an understudy competent by and by to take over the tasks of this master hand at this highly specialized work; but it is doubtful if anyone else within five counties has the special knack of understanding and coaxing governors to do their best work that this one employee possesses.

The company is fortunate enough to have the services of a man with a real genius in this direction, and mere organization is a secondary consideration so long as those services are available. Mere assemblage of machinery, as a power plant appears to be, it none the less has an identity of its own—a personality we had almost said—and without decrying the value of scientific organization, the engineer who rises above mere routine and who fits his men and tools to his work can sleep easily so far as the danger of successful attack upon his organization is concerned on the basis of its so-called lack of symmetry.

⁂

In excavating for the subways in New York, water in troublesome quantities was encountered at Canal St. and Broadway, it being necessary at one time to handle some twenty million gallons per day. If underground water in any such amount as this is available for the mere digging and pumping, some of the down-town power plants in the city better find out what they have under them.

⁂

Our attention has been called to an error in the title on page 842, June 22 issue—"Snapshots Along the Big Creek Development." The photographs refer to the developments of the Southern Sierras Power Co., notably along "Bishop's Creek" and not the Big Creek development, which belongs to the Pacific Light and Power Corporation.

Correspondence

Stokers in Marine Practice

Referring to your editorial in the June 15 issue under the title, "Stokers for Locomotives"—the last paragraph thereof, where you refer to the use of mechanical stokers for marine practice—we beg to call your attention to the fact that Jones stokers have been installed in marine service in the past and have proved successful.

The wording of the last sentence of the last paragraph of this editorial rather questions the absolute success of mechanical stokers in general as applied to stationary service. Do you still believe that the success of mechanical stokers for stationary service on land has not yet been demonstrated? If it has, and we are reasonably certain that such is the case, it would appear that the next consideration would be the following:

In what respect, or respects, do the conditions governing the installation of successful mechanical stokers in marine practice differ from the same conditions governing an installation of successful stokers for stationary practice on land?

In view of the great number of marine-type boilers which are now used on land for stationary service, and which are successfully equipped with mechanical stokers, as well as the great number of stationary-type boilers (water-tube) used in marine practice, which boilers are equipped with successful mechanical stokers on land, is it not time, and is it not proper, that marine men realize the absolute success of mechanical stokers as applied to the same types of boilers. whether used on land or on water?

W. J. Kenny, Chief Engineer,
The Under-Feed Stoker Co. of America.

[We do believe that the success of the mechanical stoker for stationary service is complete. The last sentence read: "Indications are that marine men are going to be true to tradition and not adopt the stoker until its success has been absolutely assured *everywhere* else."

One of the chief reasons given for the absence of stokers aboard ship is that coal storage and handling conditions make necessary the employment of many coal passers, and this would be true even if stokers were used, so the labor charge would not be considerably reduced. Another reason is that high boiler settings, productive of best results with stokers, are not available on shipboard.—Editor.]

Cutting Cost of Lubrication

About the first question that confronted the writer after taking charge of the buying of general supplies for a corporation owning several plants was, "How should we buy our cylinder and engine oils?" Ordinarily the superintendent or the engineer sets an arbitrary figure as to what he thinks a good oil should cost and then uses enough to be sure that the machinery is well-lubricated. This practice looked rather crude—it was merely guesswork. We knew that up to a certain limit the more paid per gallon the less oil was used, but we didn't know the economical price.

We decided to figure it out on a scientific basis. Samples of various grades of both cylinder and engine oils were received from several companies. These were sent to a chemist, and he analyzed them for fire test, viscosity and other things. When he made his report we compared each analysis with the price and in this way located the brands which gave us most for our money. Thus far it looked as though we were on the right track, but, when we started to use these oils our trouble began. Chemically they were perfect, but the physical test was a failure—they would not properly lubricate our machinery, and we immediately discontinued their use.

After much experimenting with different-priced oils, we decided to put the proposition up to the oil companies themselves. This seemed logical and we wondered why we had not thought of that before. They certainly should know more about lubrication than anyone else. Three of the leading oil companies were called in and our plan submitted to them. We were to turn the lubrication of our entire plant over to each of them for a three months' competitive trial. They were to have full charge. The gallon price was ignored. All that concerned us was, "How much can you lubricate our plant for per month?" They all were anxious to work it out along this line.

The first company to start the test sent its expert to our plant. He gathered all the data regarding style and capacity of our equipment. Then he picked the grades of oil to use. The grades were changed several times during the test until the economical combination was reached. He rearranged and added to our oil pans and guards around our machinery, so that every bit of oil running or spattering off the bearing was reclaimed, filtered and used again.

This expert also found that our oilers were using too much oil. He cut down the amount to an amazing degree. Our men at first claimed that they could not keep the engines cool with the amount of oil he specified. The expert agreed to assume all responsibility for damage, however, and the men soon discovered that his figures were correct, and that they had previously been wasting a great amount of oil. After this the oil man had the hearty coöperation of all our employees. We locked up our oil supply and instructed our storekeeper to give each oiler so much oil per day and no more. This is vitally necessary.

There was fierce conflict among the three competing oil companies. Each in turn added oil-saving devices here and there, and when the test was over the results were remarkable. Our monthly lubrication costs up to the beginning of the tests were figured, and we were startled to learn that the company which won the contest had reduced our lubrication bills more than half.

Those who are buying oils by the gallon and letting their oilers take as much as they want, by the method here outlined can certainly save money.

L. G. Fairbank.

Akron, Ohio.

Unusual Piston Failure*

Early one morning I received a report that the 20&37½x18 cross-compound engine in the plant was acting strangely. There was a slight drop in voltage and frequency, but aside from a little steam escaping from the eyebolt hole in the cylinder head there was nothing unusual to be seen. The engine was running more quietly and in the low-pressure cylinder there was none of the creaking sound that we had been unable to account for or eliminate when the engine exhausted against a back pressure.

As soon as the load could be shifted to another unit, we removed the cylinder head and to our surprise found the low-pressure piston broken into small pieces except the bullring, which was intact and about midstroke.

The engine was needed to carry part of the peak load, so we removed the piston rod from the crosshead, closed the stuffing-box steam-tight, replaced the cylinder head with a gasket under it and operated the engine with the high-pressure cylinder at about half load until a new piston and head were received. It is likely that the injury to the piston occurred while the engine stood idle in an abandoned plant and partly under water for nearly ten years before being brought to our plant. The peculiar sound in the cylinder referred to was caused by the cracked piston.

EDWARD HORSFIELD.

New Brighton, Penn.

Supporting Horizontal Return-Tubular Boilers

I read with interest the article by F. W. Dean on "Supporting Horizontal Return-Tubular Boilers," in the issue of June 22. I agree with Mr. Dean on the desirability of the three-point support even for very long boilers.

My letter, however, refers to the method of locating the points of support on the boiler so as to cause the minimum stress in the shell. The boiler support should be of the suspension type and have an additional plate riveted on the inside of the shell, as shown in Fig. 1, to stiffen the shell against the tendency to distortion from the true circular form. I believe that for this purpose from eight to twelve rivets should be put on each support.

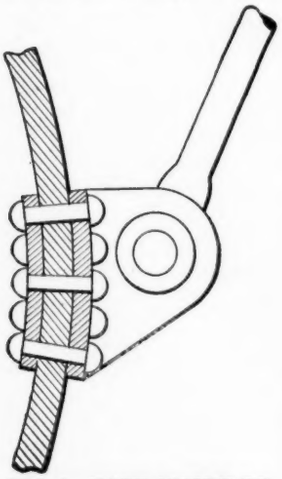


FIG. 1. NOTE INSIDE REINFORCING STRAP

To obtain the minimum stress, the boiler should be treated as a continuous beam. Thus, if L is the total length of the boiler in feet, l_1 the length of the cantilever and l the distance between supports we have $L = 2\,l_1 + l$. The weight of the tubes is neutralized by their displacement to such an extent that there is practically no reaction at the heads. This may be shown by computing the weight of a tube and also the weight of the volume of water it displaces. Further, since the weight of the boiler heads is small in comparison with the total weight of the boiler and water, we might reasonably assume that we have a uniformly distributed load. On this assumption we proceed; see Fig. 2.

The maximum bending moment in the shell produced by a cantilever of length l, and uniformly loaded is $\frac{W l_1^2}{2}$, where W = weight per foot of boiler; and for a beam fixed at the ends (continuous beam) and uniformly loaded, the bending moment at the point of support is $\frac{Wl^2}{12}$. When the latter beam is stressed there is a tension on the under side

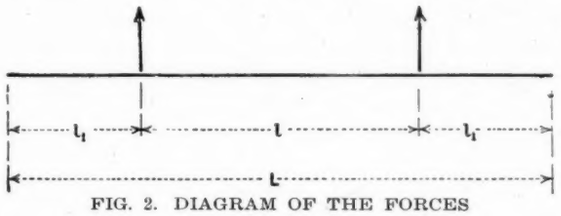


FIG. 2. DIAGRAM OF THE FORCES

at the middle of the beam and also a tension on the upper side of the points of support. To prevent a movement of a point on the top side of the sheet, just over the point of support, the stress produced by the cantilever load must be equal to that produced by the load between the supports. This condition obtains when we equate the bending moments for the two cases. Hence,

$$\frac{W l_1^2}{2} = \frac{Wl^2}{12}$$

Solving this for l we get

$$l = l_1 \sqrt{6} = 2.45\, l_1$$

Now since

$$L = 2\, l_1 + l \text{ and}$$
$$l = 2.45\, l_1$$

we have

$$L = 2\, l_1 + 2.45\, l_1 = 4.45\, l_1$$

hence

$$l_1 = \frac{L}{4.45}$$

which is the final equation desired.

It will be seen that the equation does not involve the weight W per foot of boiler, and hence the length between supports and the length of the cantilever is independent of the weight.

As an example, suppose a boiler is 20 ft. long, then the distance from the heads to the supports should be $\frac{20}{4.45} =$ 4.5 ft. so that the distance between supports will be

$$l = 20 - (2 \times 4.5) = 11\ ft.$$

ALPHONSE A. ADLER.

Brooklyn, N. Y.

Moisture in Furnace Air

In Leon Lewis' article in the issue of July 6, page 25, I think he has missed two essential differences between iron blast-furnace practice and boiler-room work, which invalidate his argument. In the first place, the atmosphere of the blast furnace is reducing at all points except just around the tuyere openings. Even the effluent gases are strongly so. For instance, typical iron blast-furnace gases contain 20 to 32 per cent. CO, 0 to 6 per cent. hydrocarbons, 55 to 65 per cent. N_2, 6 to 18 per cent. CO_2

*May 18, p. 689, and June 22, p. 854.

and 1 to 6 per cent. H_2. All of the heat energy that has gone to decompose water vapor to produce this hydrogen has been wasted, so far as the blast furnace is concerned, although part of it is recovered in the blowing engines.

In boiler-room practice flue gases such as the foregoing would call for a swift kick for the fireman. Even though the steam jet does cool the fire through the reaction, $H_2O + C = H_2 + CO$, this is all regained in the combustion chamber, where $H_2 + CO + O_2 = H_2O + CO_2$. Of course, the steam jet does not give any additional fuel, even if it does give water gas; the energy given out by the combustion of the hydrogen is just that absorbed by the decomposition of the water. It is merely a case of where you want to have that energy, whether the steam jet furnished some required draft not otherwise obtainable, and whether or not it produces in the ash or clinker certain desirable physical changes which reduce the fireman's labor.

Another essential difference between blast furnace and boiler practice is the temperature necessary. It is always easy to get nearly enough heat to smelt, but to climb the last little hill of degrees to where one can smelt well is sometimes difficult. Hence it is that in blast-furnace practice the hot-blast is used. Who would use an air-blast in boilers heated to 1450 deg. F.? The blast-furnace man now thinks it almost a necessity, for he carries a temperature at the tuyeres of about 3600 deg. F. When such temperatures are necessary and dry air can be obtained, the smelter can ill afford the heat units necessary to decompose water vapor inside his furnace; the fireman, carrying as a maximum 2200 to 2500 deg. in his combustion chamber, can.

DONALD M. LIDDELL.

Elizabeth, N. J.

Theoretical Efficiency of Heat Engines

Mr. Gasche's letter of June 1 on the Theoretical Efficiency of Heat Engines, in which he criticizes my article of Apr. 20, shows an apparent lack of clear thinking, as in the theoretical portion of his original paper, which was abstracted in the issue of June 9, 1914. Why imply that there is an attempt to disregard the second law of thermodynamics? This law is certainly contained in the statement that no heat engine can possibly convert into work all of the heat that it receives. The purpose in reasoning out the ideal efficiency of any plant is to make this law definitely quantitative, or to find for the given set of major conditions the greatest proportion of supplied heat that can imaginably be converted. But unless the ideal efficiency is determined by the particular governing conditions, it is of no value as a standard of comparison.

In the Carnot scheme and in the equivalent regenerative cycles all the heat is received by the medium from the external source at a constant temperature T_1, and all the heat not converted is given up to the external cooler at a constant lower temperature T_2. The absence of all secondary wastes being assumed, the efficiency is

$$E = \frac{Q_1 - Q_2}{Q_1} = \frac{T_1 - T_2}{T_1}$$

The first expression, in terms of heat quantities Q_1 (received) and Q_2 (rejected), is a general one, having the same form for any engine. The second, in terms of absolute temperatures T_1 and T_2, is the particular value for the case of purely isothermal heat transfer. It is wrong to call the Carnot efficiency the "perfect gas formula," because it is entirely independent of the kind of medium employed.

In the common form of steam-power plant the governing conditions are: (1) A constant boiler pressure, under which all heat transfer from fire to water or steam takes place; (2) a constant exhaust or condenser pressure; (3) no intentional transfer of heat during the expansion from high to low pressure; (4) a scheme of feed-water supply which, at the best, can return water to the boiler at the temperature of exhaust.[1] Under these conditions, and assuming that there are no losses of heat from the steam by conduction and radiation or of pressure by friction and wire-drawing, that there is no thermal action by containing walls, and that no mechanical energy, once developed, is reconverted into heat through waste motions, we reason out the Clausius or the Rankine cycle as the form of ideal action. Although most of the heat is received at constant temperature during vaporization, isothermal reception is not possible during the rise from feed temperature to boiling point and in the operation of superheating. Only the last little bit of heat comes in at the final temperature of the superheated steam, and it is therefore entirely improper to use that as T_1 in the Carnot formula.

A good deal of what Mr. Gasche says is based on a misunderstanding or a peculiar understanding of terms. In the article of Apr. 20 as clearly as here, the word "ideal" is taken to mean, not the best possible under any and all conditions that may be thought of, but the best possible within the limits set by the governing conditions of the particular plant or problem. Recognizing this restriction, the futility of wandering off into a discussion of the different schemes of regenerative feed heating becomes apparent.

A peculiar idea appears also in the last paragraph of the letter, in the remarks about boiler pressure. Ideal efficiency can be calculated just as easily for 700 lb. or for 12 lb. absolute as for 180 lb. gage pressure, but each case will have its own result, depending upon the prevailing conditions.

ROBERT C. H. HECK.

New Brunswick, N. J.

Regenerating Storage Batteries

Among all the troubles of the lead storage battery, there is no one thing which is so generally acknowledged, and then so quickly ignored and evaded, as "sulphating." By this, I do not mean normal sulphating, which is the usual and correct occurrence in normal discharge, but instead, that whitening, crystallizing deadening which attacks every plate as it stands in the electrolyte for months, and under most diverse conditions of alternate oxidation and reduction, at alternate poles. This undesirable sulphating, which does not yield to the regenerating influence of the customary charge and discharge—this slow and gradual old age, which creeps stealthily over and through the

[1] A discussion of the last point, with special reference to the raising of feed temperature by the exhaust from auxiliaries, will be found in an article by the writer on "The Limiting Efficiency of Steam Plants," in "Power" for July 2, 1912.

plates—is the one substantial cause of decay of all batteries. It takes but a glance with a pocket lens at any lot of discarded batteries to see that the plates met the common destiny of plain old-fashioned sulphating. Now it is not far from the truth to confess that if we could only control this troublesome sulphating in the hard crystalline way, we would go far toward lengthening the efficient life of the plates.

It would perhaps be too far afield to ask just here, why the makers have not been interested in overcoming this universal disease of battery plates. Be that as it may, the fact remains that the life of the ordinary storage battery is measured not by years as it ought to be, but by months. Now, if there was some method for the real regenerating of aged batteries and for bringing them back again to some fair approximation to their normal condition and efficiency, and thus doing much to add to their short life, would it not be worth while?

Such a method has been worked out and is ready for commercial application. It has regenerated the most unpromising specimens of "junk" batteries that could be found—provided that the grids were mechanically sound, and even if they were partly stripped of paste. The process has taken batteries that were worthless except for the lead that was in them and has brought them back to normal conditions; and the regenerated batteries have held their own for nearly a year and with no signs of falling off in efficiency. If this has been done with such poor specimens as were gathered in an attempt to find the worst cases, careful and systematic application on a large scale should give still more decisive results. The main point is that the method is already in hand, and the storage battery will yet vindicate itself as one of the chief means for the cheap and handy use of power.

CHARLES S. PALMER.

Newtonville, Mass.

[Details of the process will be available later.—Editor.]

Centrifugal Boiler-Feed Pumps

My business has taken me into many power plants throughout the entire country, and I have a keen interest in power-plant equipment in general.

As I have talked with chief engineers there has constantly recurred to my mind the question, "Why are centrifugal pumps not making greater headway for boiler feeding?" The general points of advantage of the centrifugal pump for this particular service are as follows: A steady flow of water at all times, avoiding water hammer, consequently reducing the labor and material expense for renewals; comparatively small cost of steam or electric current for operating; absence of valves and few working parts; accessibility of interior; adaptability to the use of automatic pressure regulation to maintain a uniform feed-water pressure above the boiler pressure; small space occupied.

I have seen centrifugal boiler-feed pumps in large and small plants, for high and low pressures and temperatures, and in every case I have found the chief engineers enthusiastic over their performance and advantages.

On the other hand I presume at least 75 per cent. of the specifications for new power plants call for the reciprocating type of boiler-feed pump and old plants continue to purchase them for replacements.

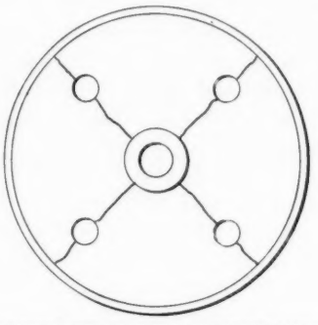
Have the centrifugal-pump manufacturers neglected an opportunity to present their arguments in a favorable and convincing manner to engineers, or am I wrong in my conclusions that their more general installation is warranted? I believe that a very useful discussion can be given to this subject by *Power* readers, and I hope this may be the means of "starting something."

CHARLES G. RICHARDSON.

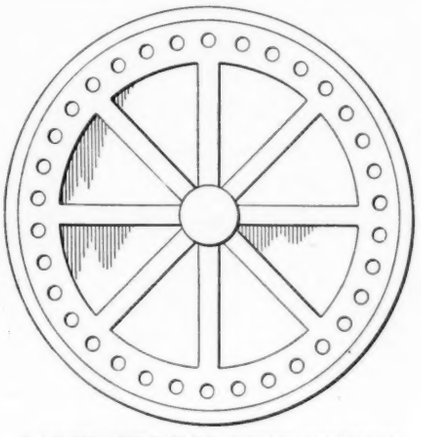
Providence, R. I.

Corliss-Engine Wristplate Repair

I worked in a place some time ago where an accident occurred that broke the wristplate of an Allis, blowing the engine into four pieces. It would have taken three weeks to get one from the factory and it was necessary to have the engine running as soon as possible. The pieces were put on blocks, so they were as near in place and level as possible. Making a band of 1x1¼-in. iron, ¼ in. smaller than the diameter of the wristplate, heating it to a dull red and shrinking it on, we had the engine running in four hours, and the job lasted until a new wristplate could be obtained from the factory.



BROKEN WRISTPLATE REPAIRED



LARGE CYLINDER HEAD BANDED

An accident to a 50x60-in. Weimer blowing engine broke the cylinder head. It was repaired by putting a thick coating of red lead at the break between the two parts, and making a band of 1⅛x2-in. iron, ¼ in. smaller in diameter than the head, heating it in a wood fire and shrinking it on. After it had cooled, a patch was made of ¼-in. plate, 4 in. larger than the piece broken out, and put on with capscrews. This break has shown no leak and has been in continuous service for one year.

FRED K. GINTHER.

Leetonia, Ohio.

New England States Association N. A. S. E. Convention

The annual convention and mechanical exhibition of the New England States Association of the National Association of Stationary Engineers took place at Holyoke, Mass., July 7-10, with headquarters at the Nonotuck Hotel.

The sessions were held in Temperance Hall. There was a large attendance of delegates and many important matters conducive to the welfare of the organization were settled. The secretary's report showed the association to be sound financially.

The large assembly room of the Holyoke City Hall was neatly decorated and arranged for the mechanical exhibit. The opening of the display was held at 8 o'clock Wednesday evening. The speakers were: Mayor John H. Woods of Holyoke; William K. Campbell, of Boston, president of the New England Association of Commercial Engineers; John S. Lyons, of Holyoke, manager of the Board of Trade; Major James W. H. Myrick, of Boston, and Past-National-President P. H. Hogan, of Boston.

On Friday morning at 10:30 the preliminary exercises of the convention took place. Fred N. Ricker, chairman of the local association, occupied the chair and after a brief address introduced Mayor John H. Woods, who welcomed the convention to Holyoke and hoped that its visit would be pleasurable and profitable. Thomas A. Ray, president of the New England Association of Stationary Engineers responded. Dr. John S. Lyons, managing director of the Chamber of Commerce, was then introduced, and spoke of the scenic beauties of Holyoke and of its great commercial interests. Past-National-Presidents Edward H. Kearney and William J. Reynolds made interesting and instructive addresses concerning the N. A. S. E. Walter H. Damon, national-vice-president, told the delegates that he hoped to see a big increase in the membership of the association, and asked the delegates to stir themselves in that direction. Riley Daniels, vice-president of the New England association, complimented the committees on the success of the convention.

President Thomas A. Ray then took charge and the convention went into executive session. A resolution by Past-National-President Kearney to send a wire to President Woodrow Wilson tendering him the loyal support of the convention in his efforts to promote and influence a policy of peace on the American continent was adopted. The necessary committees were then appointed, and an adjournment was taken.

On Friday evening a smoker was held in Temperance Hall, with Herbert E. Stone as the master of ceremonies. Herbert E. Self, of the Peerless Rubber Manufacturing Co.; Joe McKenna and Billy Murray, of Jenkins Bros.; Jack Armour of "Power," and the Harmony Quartette furnished the entertainment.

On Saturday morning at 8 o'clock automobiles took the convention on a ride through the city and to the famous Mount Tom. At 10:30 special trolley cars were boarded for Piquot Lake, where a clambake was served. A ball game between the operating and commercial engineers was won by the former by a score of 12 to 2.

At the final meeting of the delegates the following officers were elected for the ensuing year: Riley Daniels, president; John F. Quinn, vice-president; James Henderson, secretary; Walter H. Damon, treasurer; Andrew Waite, conductor; Timothy F. Hogan, doorkeeper. Past-President A. M. Day was the installing officer.

At the closing session of the Commercial Engineers on Friday afternoon the following officers were elected: Major J. W. H. Myrick, president; Charles G. Campbell, vice-president; Herbert E. Stone, treasurer; William K. Campbell, Claude D. Allen and Fred A. Forseman, directors.

The following presentations were made: To William Shaw, retiring president of Holyoke association No. 29, a badge; to Thomas A. Ray, retiring president of the New England States Association, a silver service; to William Campbell, retiring president of the Commercial Engineers, two traveling bags.

Fall River, Mass., was selected as the meeting place in 1916.

GATHERING AT THE NEW ENGLAND STATES N. A. S. E. CONVENTION IN FRONT OF HOLYOKE CITY HALL

The list of exhibitors follows:

Albany Lubricating Co.
American Steam Gauge & Valve Manufacturing Co.
American Steam Packing Co.
American Writing Paper Co.
Ashton Valve Co.
Autoforce Ventilating System
Braman, Dow & Co.
Budd Grate & Foundry Co.
Buhne Metal Packing Co.
Byers Co., A. M.
Cave Welding Manufacturing Co.
Chapman Valve Manufacturing Co.
Chase & Cooledge Co.
Chesterton Co., A. W.
Chicago Pneumatic Tool Co.
Climax Smoke Preventer Co.
Commercial Chemical Co.
Keystone Lubricating Co.
Lagonda Manufacturing Co.
Lunkenheimer Co.
Manning, Maxwell & Moore, Inc.
Mason Regulator Co.
Matchless Heater Co.
McClave-Brooks Co.
McLeod & Henry Co.
Nashua Machine Co.
"National Engineer"
New York Belting & Packing Co.
New England Hose Co.
N. Y. Revolving & Portable Elevator Co.
Open Coil Heater & Purifier Co.
Patterson Lubricating Co.
Perfection Grate Co.

Couch, L. A.
Cowan Truck Co.
Crandall Packing Co.
Deane Steam Pump Co.
Dearborn Chemical Co.
Dick Co., R. & J.
Eagle Oil & Supply Co.
Economy Lubricating Co.
Engineering Supply Co.
Evans Mill Supply Co.
Friedrick Co., E. H.
Gardner Grate Co.
Garlock Packing Co.
Hart-Edison Packing Co.
Hartford Mill Supply Co.
Hart Packing Co.
Hinds & Coon
Holyoke Valve & Hydrant Co.
Holyoke Supply Co.
Holyoke Belting Co.
Home Rubber Co.
Jenkins Bros.
Johns-Manville Co., H. W.
Peerless Rubber Manufacturing Co.
Philadelphia Grease Manufacturing Co.
"Power"
Pratt & Cady Co., Inc.
Quaker City Rubber Co.
Roto Co.
Restein Co., Clement
Revere Rubber Co.
Russell & Co., J.
S.-C. Regulator Co.
Strong, Carlisle & Hammond Co.
Schumaker-Santry Co.
Stevens Regulator Co.
Sullivan Co., C. F.
U-Auto Varnish Sales Co.
Walworth Manufacturing Co.
Walsh's Holyoke Steam Boiler Works
Winn, William R.

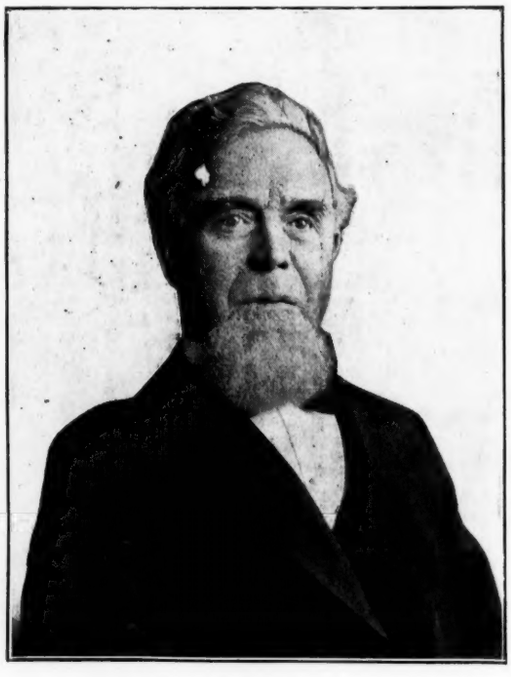
OBITUARY

ALLEN W. SWIFT

Allen Wood Swift died June 9 at Elmira, N. Y. He was the founder of the Swift Lubricator Co., of Elmira, and had been its president for 33 years.

ANDREW ALLAN, SR.

Andrew Allan, Sr., died at Asbury Park, N. J., on July 6. He was born 78 years ago in Edinburgh, Scotland, where he served his apprenticeship in the brass foundry and finishing shops of the Laidlaw Works. He came to this country in 1857 and was employed as a brass molder in the Mitchell Vance Chandelier Works and H. R. Worthington's Hydraulic Works. In 1865 he was placed in charge of the H. F. Johnston's Brass Works, New York City, a position he held until

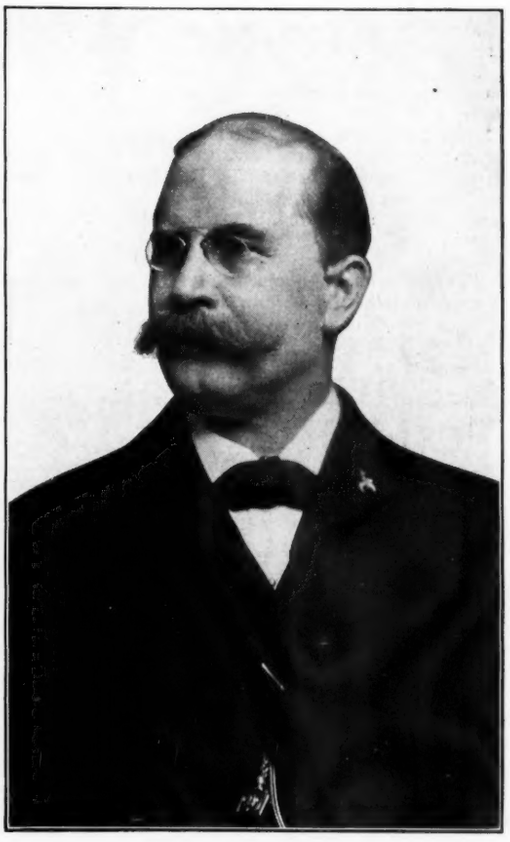


ANDREW ALLAN, SR.

1891, when the firm retired from business. He founded the firm of A. Allan & Son in the same year to manufacture the "Allan Metal" bearing alloys. He retired from active service in 1909 and had since acted in an advisory capacity. His most noteworthy metallurgical accomplishment was the introduction of high percentages of lead in copper-base bearing alloys. In 1876 he invented the process of alloying lead and copper in any desired proportion, with or without tin and was the first to put such alloys on the market. He is survived by a wife, two daughters and three sons.

CHARLES H. WEEKS

Charles H. Weeks, member A. S. M. E. since 1892 and for 40 years actively identified with the Buckeye Engine Co., died at Salem, Ohio, July 9, 1915, from arterio-sclerosis, after three years' illness. He was born in 1844 near North Vasselboro, Maine, and went to Salem at the age of 14. As a locomotive engineer on the Cleveland, Painesville & Ashtabula R.R., later the Lake Shore, he drove the funeral train of the martyred Lincoln over that section on the journey to his Western home. During President Grant's administration he was stationed at a trading post in the Indian Territory. He became sales en-



CHARLES H. WEEKS

gineer with the Buckeye Engine Co. in 1873 and was in charge of the Cincinnati office during the early 80's. He returned to Salem as sales manager of the company in 1895 and was made vice-president in 1903. Mr. Weeks early identified himself with the local Masonic bodies and was a member of Syrian Temple of the Mystic Shrine, at Cincinnati, where he made his home for a short time. As one of the older residents of Salem, always actively connected with its development, he had a large number of friends to whom his passing has come as a severe shock.

WILLIAM H. GERRISH

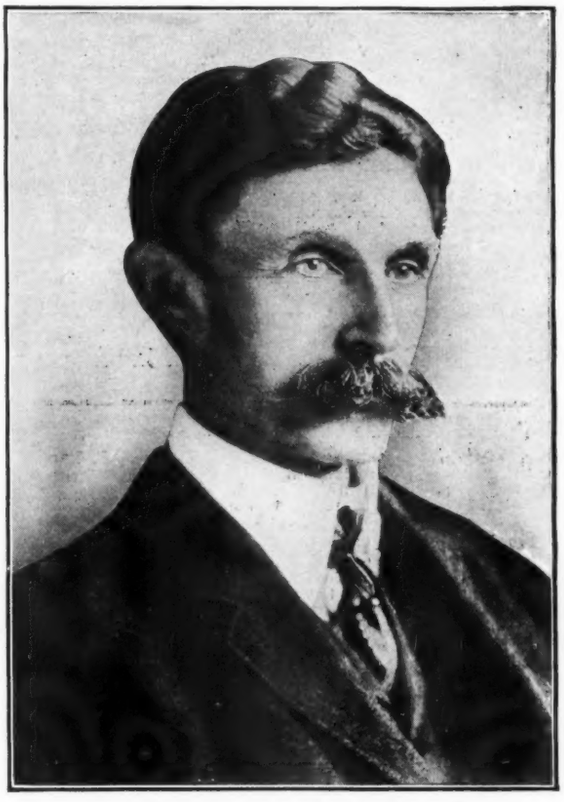
William H. Gerrish, chief smoke inspector for the Massachusetts Gas and Electric Light Commission, died at Malden, July 15, as the result of burns received in a garage fire. Mr. Gerrish was widely known and respected among steam engineers and firemen in eastern Massachusetts, and was singularly successful in the administration of his office, to which he brought a practical appreciation of the problems of combustion as met by the power-plant operator. He was born in Lowell, Mass., 49 years ago, and after graduating from the Institute of Technology in 1888 was mechanical superintendent of the Massachusetts Cotton Mills at Lowell. During the Spanish-American War he was connected with the Ordnance Department at Washington, D. C., and later became superintendent of jute mills at Paterson, N. J., and New York City. He was appointed smoke inspector at Boston in 1910, and the practical application of the Massachusetts smoke law had been almost entirely in his hands from its inception. He was occasionally called to other cities to lecture upon the subject of smoke prevention, and his death deprives both the state and the steam-engineering profession of a specialist of high standing. He is survived by a widow and a daughter.

JOSEPH A. HOLMES

Joseph Austin Holmes, director of the Federal Bureau of Mines and a widely known geologist, died July 13 at Denver, of tuberculosis. He was born 55 years ago at Laurens, S. C., and after graduating in 1881 from Cornell University, be-

came professor of geology and natural history at the University of North Carolina. While a member of the faculty he was also appointed state geologist, and held both positions until 1904, when President Roosevelt appointed him chief of the United States Geological Survey Laboratory in charge of the testing of fuels and structural materials. His services in this position were so noteworthy that he was soon given supervision of the investigation of mine accidents.

President Taft in 1910 appointed Doctor Holmes head of the newly created Bureau of Mines. Under his management great progress was made in protecting mine workers. He organized at Pittsburgh in 1911 the first national mine safety



JOSEPH AUSTIN HOLMES

demonstration, which showed mine owners, superintendents and miners many ways of preventing dangers and loss of life. One of Doctor Holmes' most important discoveries was that the dust from bituminous coal was more dangerous to miners than fire damp.

Besides his Cornell B. S. he received the degree of LL. D., University of North Carolina, and D. Sc., University of Pittsburgh. He was a member of the National Conservation Commission, Mining Legislation Commission of Illinois, American Society for Testing Materials, American Institute of Mining Engineers, American Society of Mechanical Engineers, Engineers' Club of New York, and was also a fellow of the Geological Society of America. Dr. Holmes' health was seriously affected by frequent visits to mine disasters and by his continually sharing the dangers that should only have gone to more robust men. Two years ago he visited the Alaskan coal fields and met with hardships that are believed to have hastened the end.

NEW PUBLICATIONS

PRACTICAL LESSONS IN ELECTRICITY. By Robert A. Millikan, professor of physics, University of Chicago; Francis B. Crocker, professor of electrical engineering, Columbia University; and John Mills, engineering department, American Telephone and Telegraph Co. Published by the American Technical Society, Chicago, Ill. Cloth, 328 pages; 5½x8½ in.; 319 illustrations. Price, $1.50.

This book, according to the introductory note of the publishers, is an attempt to present briefly, first, a rapid survey of elemental principles, and second, a few particular applications to the field of direct and alternating currents. The book is divided into four sections, numbered separately. For instance, the reader interested in "solenoids," finds them indexed under Part II, page 9, and then is put to the inconvenience of searching until he finds the second page 9 in the book. The first section contains a clearly written description of the phenomena connected with magnetism, static and moving electricity, primary cells, and with their application to the simple forms of telegraph and telephone equipment. The principles of direct-current generators are touched upon in the second section, the treatment being somewhat more advanced. Nearly twenty pages on the theory of commutator sparking and the methods of construction for its prevention would seem to indicate that this part of the subject is treated at unnecessary length, particularly as there is very little information on windings and commercial application of generators. Direct-current motors are absolutely ignored. In Part III, on elements of alternating current, the calculus is used at length to show the relation between current and electromotive force. Extended use is made of complex and imaginary quantities. This method of notation is illustrated by a number of problems. The last section of the book is devoted to storage batteries. Here an effort seems to have been made to give a really all-around treatment of the subject matter, and it is therefore to be regretted that the statements are not always accurate. For example, referring to a particular battery, it is said that there are twice as many positive as negative plates in a standard cell. In another place the correct statement is made that each cell has one more negative than positive plate. Too many cooks may spoil the broth in a book as well as in a kitchen. The appearance the work has of being incomplete as to many fundamental and replete as to less important facts may, even though unconsciously, be caused by the triple authorship. The authors are authorities in their particular fields, and some valuable theoretical material is scattered through the book.

DESIGN OF STEAM BOILERS AND PRESSURE VESSELS. By George B. Haven, professor, and George W. Swett, assistant professor of machine design, Massachusetts Institute of Technology. Published by John Wiley & Sons, Inc., New York. Cloth, 416 pages; 6x9 in.; 197 illustrations; 54 tables. Price, $2.50.

At least three-quarters of this treatise is generally applicable to boiler design, while the remainder relates to specific design of selected types. The design of water-tube boilers has not been included. According to the authors, their proportions can rarely be determined by calculation, but are largely the result of ripe experience and well-established precedent. The book opens with a brief review of the present status of the industry, considering boiler materials, construction, superheaters, grate setting and water circulation. This section concludes with a summary of the Massachusetts boiler rules directly affecting steam-boiler design. Next comes a discussion of the stresses in cylinders, spheres, flat plates, dished heads and spiral seams. The treatment is a summary rather than a derivation of the best-known methods of calculating stresses. The chapter on riveted joints outlines the calculation of efficiencies and concludes with tabulations showing maximum pitches, efficiencies and calking distances for the common joints. A chapter is devoted to such considerations as water consumption, fuel combustion, grate surface, tubes and furnaces and to the general dimensions and proportions of boilers. The principles laid down are used to work out complete designs of a horizontal return-tubular, a dry-back Scotch, a vertical multi-tubular and a locomotive-type boiler and a vulcanizer tank. In each case there are given: First, general specifications for the particular type; next, a complete solution of the problem based on the assumed data; and finally, the complete calculations and drawings of the actual apparatus. In addition to the examples of the designs of complete boilers, a number of problems are scattered through the text to show the use of the formulas and data given. A feature that should make the book valuable to those interested in boiler design is the large number of tabulations and plots. These are mostly calculated from the formulas, but the former comprise also properties of standard materials of boiler construction.

500 PLAIN ANSWERS TO DIRECT QUESTIONS ON STEAM, HOT WATER, VAPOR AND VACUUM HEATING. By Alfred G. King. Published by the Norman W. Henley Publishing Co., New York City. Cloth, 214 pages; 6x9 in.; 127 illustrations. Price, $1.50.

While this book is intended for apprentices and steam fitters, the treatment of the subject matter is so clear and complete that it should prove valuable to anyone interested in the various systems of heating. Heat-generating apparatus seems somewhat slighted, the greater part of the book being devoted to the other parts of the heating systems. The first chapter deals briefly with chimneys, fuels, heating boilers and with their trimmings and settings. This section has not the clearness and completeness which seems to be present elsewhere. For example, we are told that boilers are rated by their horsepower, but the next answer defines horsepower as work required to raise 33,000 lb. one foot per minute. The value of the book would seemingly have been increased if a

better description of heating boilers had been included. But this sort of information may not be needed by steam fitters. At any rate, the rest of the book is excellent. The elementary theory and the practical construction of heating systems are described. Simple rules are given for determining the sizes of valves, piping and radiators. The advantages claimed and the apparatus required for the systems mentioned in the title are all adequately considered. Few photographs are used, but many line, section and perspective drawings clearly supplement the answers to the questions.

THE AMERICAN STANDARD FOR PIPE FLANGES, FITTINGS AND BOLTINGS. Report of Committee on Standardization of Flanges. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City. Paper, 57 pages; 6x9 in.; 35 illustrations. Price, 50c.

These standard dimensions were arrived at after a long series of conferences between the Manufacturers' Committee and the Committee on Standardization of Flanges of the American Society of Mechanical Engineers. The result is a compromise, consistent with good engineering practice, between the 1912 U. S. Standard heretofore recommended by the society committee and the Manufacturers' Standard adopted in 1912. In order to provide for the large sizes of pipes now required with steam-turbine installations, the standard-weight, or low-pressure, sizes have been extended from 30 in. to 100 in., and to take care of high-pressure water mains the extra heavy, or high pressure, sizes have been extended from 24 to 48 in. Copies of the pamphlet may be obtained on application to the society.

PUBLICATIONS OF DEPARTMENT OF COMMERCE

The Division of Publications of the department twice yearly issues a pamphlet containing the titles of all available department publications, full instructions as to how they may be obtained, and condensed information concerning the scope of its work. There is also issued monthly a list of publications available for distribution during the month. Those desiring to receive these publications regularly should apply to the Chief Division of Publications, Department of Commerce, Washington, D. C.

ELECTRICAL MEASURING INSTRUMENTS

Circular No. 30, of the Bureau of Standards, describes the operating principles of such electrical instruments as ammeters, voltmeters and wattmeters. It gives information on the errors of instruments that will assist those who use them to obtain the most accurate results. It treats briefly current and voltage transformers, standard apparatus for checking ordinary instruments and the design of electrical instruments. Copies may be obtained from the Bureau of Standards at Washington.

BOOKS RECEIVED

STEAM BOILERS AND COMBUSTION. By John Batey. D. Van Nostrand Co., New York. Cloth; 211 pages; 4¾x7½ in.; illustrated. Price, $1.50.

PRACTICAL SHOP MECHANICS AND MATHEMATICS. By James F. Johnson. John Wiley & Sons, Inc., New York. Cloth; 130 pages; 5x7¼ in.; 81 illustrations; tables. Price, $1.

PRACTICAL APPLIED MECHANICS. By Joseph W. L. Hale. McGraw-Hill Book Co., Inc., New York. Cloth; 206 pages; 4½x7 in.; 185 illustrations; tables. Price, $1.

PURCHASING. By C. S. Rindsfoos. McGraw-Hill Book Co., Inc., New York. Cloth; 165 pages; 6x9¼ in.; illustrated. Price, $2.

TRADE CATALOGS

Hoppes Mfg. Co., Springfield, Ohio. Catalog. V-Notch meter and recorder. Illustrated, 16 pp., 6x9 in.

Chicago Pneumatic Tool Co., 1010 Fisher Building, Chicago, Ill. Bulletin E-36. Duntley electric grinders. Illustrated, 8 pp., 6x9 in.

Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin No. 1632. Centrifugal pumps and centrifugal pumping units. Illustrated, 44 pp., 7½x10½ in.

Fuel Economy Engineering Co., 2001 Finance Building, Philadelphia, Penn. Catalog. Buckley automatic feed water regulator. Illustrated, 8 pp., 4x8½ in.

Mesta Machine Co., Pittsburgh, Penn. Bulletin Ka. Horse power chart for power transmission machinery including gears, pulleys, etc. Illustrated, 4 pp., 6x9 in.

Bolinders Co., 30 Church St., New York. Catalog. "Latest Developments of Bolinder Oil Engine." Illustrated, 9½x12 in. Bulletin. Specification Table No. 1274. 16 pp., 9x12 in. Bulletin No. 15-15. Marine oil engines. Illustrated, 4 pp., 9x12 in.

BUSINESS ITEMS

Engberg's Electrical & Mechanical Works, St. Joseph, Mich., due to the increasing demand for Engberg direct-connected generating sets, searchlights and electro-hydraulic valves, has found it necessary to establish a New York office at 39 Cortlandt St.

August Mietz, 128 Mott St., New York, recently received orders for Mietz & Weiss oil engines from the following: Town of Charter Oak, Iowa, one 50-hp. and one 75-hp. for lighting plant; Baer Bros., Stamford, Conn., one 160-hp. engine; Sexauer-Lamke, Astoria, L. I., two 100-hp. M. & W. oil engines; T. B. Abell, Brooklyn, N. Y., one 25-hp. M. & W. engine; Anton Mak, West Wellington, Conn., one 25-hp. M. & W. engine; J. F. Berndez & Co., Havana, Cuba, one 25-hp. and one 35-hp. M. & W. engines The Mietz & Weiss oil engines received the gold medal at the Panama-Pacific Exposition in San Francisco, Calif.

The Flanner Water Tube Boiler Co., of Akron, Ohio, has lately concluded arrangements with the Taylor-Pearsons Mercantile Staff, 70 Fifth Ave., New York City ,to become its general northeastern sales manager to cover the New England States, New York State, New Jersey and northeastern Pennsylvania in the sale of the Flanner water-tube boiler. This boiler has created for itself a wide and enviable reputation in the West and Middle West, on account of its unusual qualities and its most modern construction, and the new connection has been made for the purpose of making this boiler as widely and favorably known in the Eastern market

NEW EQUIPMENT

ATLANTIC COAST STATES

The Canaan Electric Light Co., Canaan, N. H., has applied to the Public Service Commission for permission to operate in the towns of Canaan and Enfield, and to purchase the plant and equipment of the American Woolen Co., Enfield.

It is reported that the Hortonia Power Co., Brandon, Vt., contemplates the construction of a power plant at Hortonville, Vt.

The Hartford Electric Light Co., Hartford, Conn., has taken out a permit for the construction of a substation on Vandyke Ave. The estimated cost is $7000.

The Albany Southern R.R. Co. has been granted a franchise by the Public Service Commission to build transmission lines and install a distribution system for furnishing electricity to the town of Stockport, N. Y. George F. Silvia, Albany, is Elec. Supt. of the Albany Southern Co.

The Sleeth Mfg. Co., Belleville, N. J., manufacturer of wire specialties, will build a new boiler house at its plant on Cortlandt St., Belleville.

It is reported that bids are being asked by the City Council of Brackenridge, Penn., for the construction of an electric-lighting system. It is understood that energy will be purchased to operate the plant.

The Borough Council of Smethport, Penn., has granted a franchise to the Kane Electric Light & Power Co., Kane, to extend its transmission lines to Smethport to furnish electrical service to the town.

SOUTHERN STATES

The Norton Coal Co., Norton, Va., according to press reports, will rebuild its power house which was destroyed by fire recently at a loss of about $25,000.

It is reported that the Thread Mills Co., Spray, N. C., is having plans prepared for the construction of a 3000-hp. electric power plant. F. P. Sheldon, Industrial Trust Bldg., Providence, R. I., is Arch. and Engr.

An election will be held July 27 in Wake Forest, N. C., to vote on the question of issuing $10,000 in bonds the proceeds of which will be used for extensions and improvements to the municipal electric-light plant. J. L. Bullard is Supt. of the plant.

CENTRAL STATES

The city of North Vernon, Ind., contemplates installing an additional engine and generator and remodeling the municipal electric-light plant at a cost of about $15,000. A. B. Berkshire is Supt.

The Decatur Ry. & Light Co., Decatur, Ill., is reported to be extending its lines to Mechanicsburg, Ill., to supply electrical service.

WEST OF MISSISSIPPI

It is reported that the City Council of Bancroft, Iowa, is considering a bond issue of $10,000, the proceeds of which will be used for the construction of an electric-light plant.

At a recent election in Hazleton, Iowa, it was voted to issue bonds for the purpose of constructing a municipal electric-light plant.

The Interstate Power Co. will at once begin the construction of a new substation at Waukon, Iowa, to replace the one recently burned. The new building will be fireproof. M. S. Howard, Waukon, is Cont. Agt. and Supt.

The city of Wilton, Iowa, contemplates the installation of additional generating machinery in the municipal electric-light plant. David G. Fisher & Co., Davenport, is Engr.-in-Charge.

The citizens of Lakefield, Minn., have voted to issue $31,000 in bonds, the proceeds of which will be used for the installation of an electric-light and power plant.